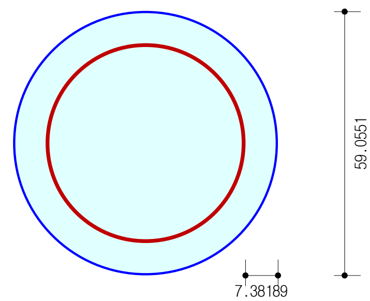
Company		**Project Title**	
Author		**File Name**	C:\...\Pier_Example.mcb

1. Design Condition



Design Code	AASHTO-LRFD12
Unit System	kips, in
Member Number	10 (PM), 10 (Shear)
Material Data	fc = 5, fy = 60, fys = 60 ksi
Column Height	393.701 in
Section Property	Pier (No : 3)
Rebar Pattern	Total Rebar Area Ast = 30.8147 in² (ρst = 0.0113)

2. Applied Loads

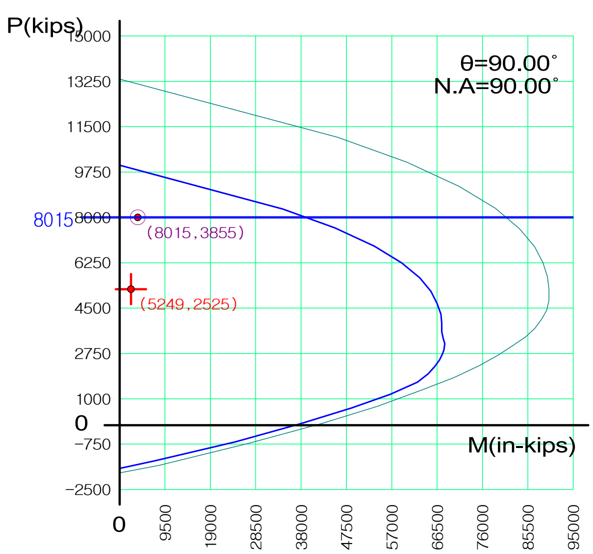
Load Combination 1 AT (J) Point

Pu = 5248.99 kips, Mcy = 0.00000, Mcz = 2524.64, Mc = 2524.64 in-kips

3. Axial Forces and Moments Capacity Check

Concentric Max. Axial Load	Pr-max	= 8015.41 kips	
Axial Load Ratio	Pu/Pr	= 5248.99 / 8015.41	= 0.655 < 1.000 .... O.K
Moment Ratio	Mcy/Mry	= 0.00000 / 0.00000	= 0.000 < 1.000 .... O.K
	Mcz/Mrz	= 2524.64 / 3855.22	= 0.655 < 1.000 .... O.K
	Mc/Mr	= 2524.64 / 3855.22	= 0.655 < 1.000 .... O.K

4. P-M Interaction Diagram



Pr(kips)	Mr(in-kips)
10019.26	0.00
7605.31	45209.37
6267.68	59127.57
5161.34	65272.12
4289.98	67294.22
3602.08	67479.79
3130.51	68140.73
2721.70	67759.69
2256.57	66118.58
1645.27	62489.10
653.25	48642.73
-641.95	24354.76
-1663.99	0.00

5. Shear Force Capacity Check

Applied Shear Strength	Vu	= 93.3573 kips	(Load Combination 1)
Shear Strength by Conc	φV	= 152.426 kips	
Shear Strength by Rebar	φVs	= 154.531 kips	(2.0-#3 @3.2")
Shear Ratio	Vu/φVn	= 93.3573 / 306.957	= 0.304 < 1.000 .... O.K

PROJECT TITLE :

	Company		Client	
	Author		File Name	Pier_Design Detail Report

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 MIDAS/Civil - RC-Column Design   [ AASHTO-LRFD12 ]                             Civil 2016
===========================================================================================


       +==============================================================+
       |  MIDAS(Modeling, Integrated Design & Analysis Software)      |
       |  MIDAS/Civil - Design & checking system for windows          |
       +==============================================================+
       |  RC-Member(Beam or Column) Analysis and Design               |
       |  Based On  AASHTO-LRFD12, AASHTO-LRFD07, AASHTO-LRFD02,      |
       |            AASHTO-LFD96, ACI318-02, CSA-S6-00,               |
       |            Eurocode2-2:05, SNiP 2.05.03-84*,                 |
       |            SP 35.13330.2011, SNiP 2.05.03-84*(MKS),          |
       |            SP 35.13330.2011(MKS), JTJ023-85,                 |
       |            IRC:21-2000, IRC:112-2011, KCI-USD12,             |
       |            KCI-USD07, KSCE-USD05, KCI-USD99, KSCE-USD96,     |
       |                                               (c)SINCE 1989  |
       +==============================================================+
       |  MIDAS Information Technology Co.,Ltd.         (MIDAS IT)    |
       |  MIDAS IT Design Development Team                            |
       +==============================================================+
       |            HomePage : www.MidasUser.com                      |
       +==============================================================+
       |  MIDAS/Civil  Version 8.5.1                                  |
       +==============================================================+


    *.DEFINITION OF LOAD COMBINATIONS WITH SCALING UP FACTORS.
 ---------------------------------------------------------------------------------------
     LCB  C    Loadcase Name(Factor) + Loadcase Name(Factor) + Loadcase Name(Factor)
 ---------------------------------------------------------------------------------------
       1  1   DC1-1 Girder Selfweight( 1.250) +DC2-1 Barrier, Scaffolding( 1.250) +DW Wearing Surface( 1.500)
             +       L HL-93( 1.750)
       2  1   DC1-1 Girder Selfweight( 1.250) +DC2-1 Barrier, Scaffolding( 1.250) +DW Wearing Surface( 1.500)
             +       L HL-93( 1.350)
       3  1   DC1-1 Girder Selfweight( 1.500) +DC2-1 Barrier, Scaffolding( 1.500) +DW Wearing Surface( 1.500)
 ---------------------------------------------------------------------------------------
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 MIDAS/Civil - RC-Column Design   [ AASHTO-LRFD12 ]                           Civil 2016
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      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kips, in
      *.MEMBER        : Member Type = COLUMN ,  MEMB =    10,  LCB =    1,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     3) : Pier
        Column Height (L)               =      393.701 in.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =       59.055 in.
        Concrete Strength (fc)          =        5.000 ksi.
        Main Rebar Strength (fy)        =       60.000 ksi.
        Ties/Spirals Strength (fys)     =       60.000 ksi.
        Modulus of Elasticity (Es)      =    29000.000 ksi.

      *.REINFORCEMENT PATTERN :
        Concrete Cover to C.O.R. (do)   =        7.382 in.
        Total Rebar Area                =      30.81467 in^2.

      *.Ties :  2.0-#3  @24"

 ==============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kips., in.
           *.Load combination ID =    1
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL               2375.32         0.00         0.00     -7251.72      2298.36
            LL               2873.66         0.00         0.00     19073.57    -27231.34
            DL+LL            5248.99         0.00         0.00     11821.85    -24932.98
            Others             -0.00         0.00         0.00         0.00         0.00
           ------------------------------------------------------------------------------
            DL+LL+Others     5248.99         0.00         0.00     11821.85    -24932.98
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       0.00 in-kips.
           -. End Moments (My2) =       0.00 in-kips.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
           -. Radii of gyration (Roy)       =   14.764 in.
           -. Unbraced lengths  (Ly)        =  393.701 in.
           -. Effective length factors (Ky)  =    1.000
           -. SLENy  =  Ky*Ly/Roy  =   26.667  >  SRy  --->  SLENDER.

      ( ). Compute moment magnification factors for major axis(DBy,DSy).
           -. Cmy    =       0.85 (Default or User defined value)
```

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-------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Design   [ AASHTO-LRFD12 ]                              Civil 2016
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           -. Pu     =       5248.99 kips.
           -. Betady =  Mu_D/Mu_G                 =   0.0000
           -. Ely    =  Ec*Ryy/(2.5*(1+Betady))   =971888514.8272
           -. Pey    =  pi^2*Ely / (Ky*Ly)^2      =    61884.75 kips.
           -. DBy    =  Cmy/(1-Pu/(phi*Pey))      =        1.00
           -. DBy  <  1.0  --->  DBy  =  1.00
           -. DSy    =     1.00 (Default value)

      ( ). Compute magnified moments.
           -. No sidesway moments.
              QMb_y  =  My_G   =        0.00 in-kips.
           -. Sidesway moments.
              QMs_y  =  My_S   =        0.00 in-kips.
           -. Compute magnified moments.
              Mcy              =  DBy*QMb_y + DSy*QMs_y             =        0.00 in-kips.

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (Mz1) =     2298.36 in-kips.
           -. End Moments (Mz2) =     7251.72 in-kips.
           -. Slenderness ratio limits.
              SRz(Unbraced) =  22.00
           -. Radii of gyration (Roz)       =   14.764 in.
           -. Unbraced lengths  (Lz)        =  393.701 in.
           -. Effective length factors (Kz)  =    1.000
           -. SLENz  =  Kz*Lz/Roz  =   26.667  >  SRz  --->  SLENDER.

      ( ). Compute moment magnification factors for minor axis(DBz,DSz).
           -. Cmz    =        0.85 (Default or User defined value)
           -. Pu     =       5248.99 kips.
           -. Betadz =  Mu_D/Mu_G                 =   1.0000
           -. Elz    =  Ec*Rzz/(2.5*(1+Betadz))   =485944257.4136
           -. Pez    =  pi^2*Elz / (Kz*Lz)^2      =    30942.37 kips.
           -. DBz    =  Cmz/(1-Pu/(phi*Pez))      =        1.10
           -. DSz    =     1.00 (Default value)

      ( ). Compute magnified moments.
           -. No sidesway moments.
              QMb_z  =  Mz_G   =     2298.36 in-kips.
           -. Sidesway moments.
              QMs_z  =  Mz_S   =        0.00 in-kips.
           -. Compute magnified moments.
              Mcz              =  DBz*QMb_z + DSz*QMs_z             =     2524.64 in-kips.

 ================================================================================
   [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

      ( ). Compute design parameter.
           -. phi    =   0.90
           -. Alpha =   0.85
           -. Beta   =   0.80
           -. ecu    =  0.0030
```

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 MIDAS/Civil - RC-Column Design   [ AASHTO-LRFD12 ]                           Civil 2016
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     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0113
          -. As_max =  Rhomax * Ag  =    82.1724 in^2.
          -. As_min =  Rhomin * Ag  =    30.8147 in^2.

     ( ). Check moment capacity.
          -. Pr_max     =      8015.409 kips.
          -. Pr         =      8015.409 kips.
          -. Mry        =         0.000 in-kips.
          -. Mrz        =      3855.219 in-kips.
          -. Mr         =      3855.219 in-kips.
          -. Pu/Pr      =   0.655  --->  0.K !
          -. Muy/Mry    =   0.000  --->  0.K !
          -. Muz/Mrz    =   0.655  --->  0.K !
          -. Mu/Mr      =   0.655  --->  0.K !
          -. Ratio      =   0.655  --->  0.K !

 =====================================================================================
   [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 =====================================================================================

     ( ). Compute shear parameter. ( LCB = 2, POS = I )
          -. phi    =   0.90
          -. Av     =     0.2200 in^2.
          -. Pu     =       4592.15 kips.
          -. Vuz    =          0.00 kips.
          -. Muy    =          0.00 in-kips.
          -. bvz    =  59.06 in.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =  46.51 in.
          -. thetaz =  48.80 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   0.92

          -. Vuy    =         66.47 kips.
          -. Muz    =      -7684.58 in-kips.
          -. bvy    =  59.06 in.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =  46.51 in.
          -. thetay =  48.80 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   0.92
```

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 MIDAS/Civil - RC-Column Design   [ AASHTO-LRFD12 ]                           Civil 2016
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     ( ). Compute shear strength of concrete.
          -. Vuz       =        0.00 kips.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      177.66 kips.
          -. phiVcz    = phi * Vcz =      159.90 kips.

          -. Vuy       =       66.47 kips.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      177.66 kips.
          -. phiVcy    = phi * Vcy =      159.90 kips.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =   24.000 in.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   = smax_z =   24.000 in.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =   24.000 in.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   = smax_y =   24.000 in.

          -. Applied spacing s     = MIN[ s_y, s_z ] =   24.000 in.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =       22.39 kips.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     3255.35 kips.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =       22.39 kips.
          -. phiVsz   = phi*Vsz =       20.15 kips.
          -. phiVsz > (Vuz-phiVcz)  --->  0.K !
          -. Avz_req/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.1100 in^2/ft.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =       22.39 kips.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     3255.35 kips.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =       22.39 kips.
          -. phiVsy   = phi*Vsy =       20.15 kips.
          -. phiVsy > (Vuy-phiVcy)  --->  0.K !
          -. Avy_req/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.1100 in^2/ft.

          -. Vu       =      66.474 kips.
          -. Vr       =     180.049 kips.
          -. Ratio    = Vu / Vr = 0.369  --->  0.K !

     ( ). Compute minimum longitudinal reinforcement by shear.
          -. phia    =   0.75
          -. phib    =   0.90
          -. phiv    =   0.90
          -. Vs1y    =  MIN[ Vsy, Vuy/phiv ] =       22.39 kips.
          -. Vs1z    =  MIN[ Vsz, Vuz/phiv ] =       22.39 kips.
          -. Asy_req =  [ Muz/(phib*dvy)  - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay) ] / fy = -47.0496 in^2.
          -. Asz_req =  [ Muy/(phib*dvz)  - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz) ] / fy = -47.0496 in^2.
          -. As_req  =  MAX[ Asy_req, Asz_req ] = -47.0496 in^2.
          -. As      =  30.8147 in^2.
          -. As_req < As  --->  0.K !
```