PROJECT TITLE :	Acueducto Agua Bonita San José del Guaviare		
Company	Leandro Castellanos	Client	
Author	Leandro Castellanos	File Name	Tanque Elevado.rcs

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 midas Gen - RC-Column Design   [ NSR-10 ]                                   Gen 2022
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       +==============================================================+
       |  MIDAS(Modeling, Integrated Design & Analysis Software)      |
       |  midas Gen - Design & checking system for windows            |
       +==============================================================+
       |  RC-Member(Beam/Column/Brace/Wall) Analysis and Design       |
       |  Based On  Eurocode2:04, Eurocode2, ACI318-19,               |
       |            ACI318M-19, ACI318-14, ACI318M-14, ACI318-11,     |
       |            ACI318-08, ACI318-05, ACI318-02, ACI318-99,       |
       |            ACI318-95, ACI318-89, NSR-10, CSA-A23.3-94,       |
       |            BS8110-97, NSCP 2015                              |
       |                                              (c)SINCE 1989   |
       +==============================================================+
       |  MIDAS Information Technology Co.,Ltd.          (MIDAS IT)   |
       |  MIDAS IT Design Development Team                            |
       +==============================================================+
       |            HomePage : www.MidasUser.com                      |
       +==============================================================+
       |  Gen 2022                                                    |
       +==============================================================+


    *. DEFINITION OF LOAD COMBINATIONS WITH SCALING UP FACTORS.
---------------------------------------------------------------------------------------
     LCB  C    Loadcase Name(Factor) + Loadcase Name(Factor) + Loadcase Name(Factor)
---------------------------------------------------------------------------------------
      12  1              D( 1.400) +          Fh( 1.400) +           Fv( 1.400)
      13  1              D( 1.200) +      SRSS11( 1.000) +           Fh( 1.000)
            +              Fv( 1.000) +       Fhi_v( 1.000) +          Fi_v( 1.000)
      14  1              D( 1.200) +      SRSS11(-1.000) +           Fh( 1.000)
            +              Fv( 1.000) +       Fhi_v( 1.000) +          Fi_v( 1.000)
      15  1              D( 1.200) +       SRSS7( 1.000) +           Fh( 1.000)
            +              Fv( 1.000) +       Fhi_v( 1.000) +          Fi_v( 1.000)
      16  1              D( 1.200) +       SRSS8( 1.000) +           Fh( 1.000)
            +              Fv( 1.000) +       Fhi_v( 1.000) +          Fi_v( 1.000)
      17  1              D( 1.200) +       SRSS9( 1.000) +           Fh( 1.000)
            +              Fv( 1.000) +       Fhi_v( 1.000) +          Fi_v( 1.000)
      18  1              D( 1.200) +      SRSS10( 1.000) +           Fh( 1.000)
            +              Fv( 1.000) +       Fhi_v( 1.000) +          Fi_v( 1.000)
      19  1              D( 1.200) +       SRSS7(-1.000) +           Fh( 1.000)
            +              Fv( 1.000) +       Fhi_v( 1.000) +          Fi_v( 1.000)
      20  1              D( 1.200) +       SRSS8(-1.000) +           Fh( 1.000)
            +              Fv( 1.000) +       Fhi_v( 1.000) +          Fi_v( 1.000)
      21  1              D( 1.200) +       SRSS9(-1.000) +           Fh( 1.000)
            +              Fv( 1.000) +       Fhi_v( 1.000) +          Fi_v( 1.000)
      22  1              D( 1.200) +      SRSS10(-1.000) +           Fh( 1.000)
            +              Fv( 1.000) +       Fhi_v( 1.000) +          Fi_v( 1.000)
      23  1              D( 0.900) +      SRSS11( 1.000) +           Fh( 1.000)
            +              Fv( 1.000) +       Fhi_v( 1.000) +          Fi_v( 1.000)
      24  1              D( 0.900) +      SRSS11(-1.000) +           Fh( 1.000)
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PROJECT TITLE : Acueducto Agua Bonita San José del Guaviare

MIDAS	Company	Leandro Castellanos	Client	
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            +            Fv( 1.000) +         Fhi_v( 1.000) +          Fi_v( 1.000)
     25  1             D( 0.900) +          Fh( 1.000) +              Fv( 1.000)
            +          Fhi_v( 1.000) +          Fi_v( 1.000) +         SRSS7( 1.000)
     26  1             D( 0.900) +          Fh( 1.000) +              Fv( 1.000)
            +          Fhi_v( 1.000) +          Fi_v( 1.000) +         SRSS8( 1.000)
     27  1             D( 0.900) +          Fh( 1.000) +              Fv( 1.000)
            +          Fhi_v( 1.000) +          Fi_v( 1.000) +         SRSS9( 1.000)
     28  1             D( 0.900) +          Fh( 1.000) +              Fv( 1.000)
            +          Fhi_v( 1.000) +          Fi_v( 1.000) +        SRSS10( 1.000)
     29  1             D( 0.900) +          Fh( 1.000) +              Fv( 1.000)
            +          Fhi_v( 1.000) +          Fi_v( 1.000) +         SRSS7(-1.000)
     30  1             D( 0.900) +          Fh( 1.000) +              Fv( 1.000)
            +          Fhi_v( 1.000) +          Fi_v( 1.000) +         SRSS8(-1.000)
     31  1             D( 0.900) +          Fh( 1.000) +              Fv( 1.000)
            +          Fhi_v( 1.000) +          Fi_v( 1.000) +         SRSS9(-1.000)
     32  1             D( 0.900) +          Fh( 1.000) +              Fv( 1.000)
            +          Fhi_v( 1.000) +          Fi_v( 1.000) +        SRSS10(-1.000)
     33  2             D( 1.000) +          Fh( 1.000) +              Fv( 1.000)
     34  2             D( 1.000) +          Fh( 1.000) +              Fv( 1.000)
            +         SRSS11( 0.700) +      Fhi_v( 1.000) +          Fi_v( 1.000)
     35  2             D( 1.000) +          Fh( 1.000) +              Fv( 1.000)
            +          Fhi_v( 1.000) +          Fi_v( 1.000) +        SRSS11(-0.700)
     36  2             D( 1.000) +          Fh( 1.000) +              Fv( 1.000)
            +          Fhi_v( 1.000) +          Fi_v( 1.000) +         SRSS7( 0.700)
     37  2             D( 1.000) +          Fh( 1.000) +              Fv( 1.000)
            +          Fhi_v( 1.000) +          Fi_v( 1.000) +         SRSS8( 0.700)
     38  2             D( 1.000) +          Fh( 1.000) +              Fv( 1.000)
            +          Fhi_v( 1.000) +          Fi_v( 1.000) +         SRSS9( 0.700)
     39  2             D( 1.000) +          Fh( 1.000) +              Fv( 1.000)
            +          Fhi_v( 1.000) +          Fi_v( 1.000) +        SRSS10( 0.700)
     40  2             D( 1.000) +          Fh( 1.000) +              Fv( 1.000)
            +          Fhi_v( 1.000) +          Fi_v( 1.000) +         SRSS7(-0.700)
     41  2             D( 1.000) +          Fh( 1.000) +              Fv( 1.000)
            +          Fhi_v( 1.000) +          Fi_v( 1.000) +         SRSS8(-0.700)
     42  2             D( 1.000) +          Fh( 1.000) +              Fv( 1.000)
            +          Fhi_v( 1.000) +          Fi_v( 1.000) +         SRSS9(-0.700)
     43  2             D( 1.000) +          Fh( 1.000) +              Fv( 1.000)
            +          Fhi_v( 1.000) +          Fi_v( 1.000) +        SRSS10(-0.700)
     44  2             D( 1.000) +          Fh( 1.000) +              Fv( 1.000)
            +          Fhi_v( 1.000) +          Fi_v( 1.000) +        SRSS11( 0.525)
     45  2             D( 1.000) +          Fh( 1.000) +              Fv( 1.000)
            +          Fhi_v( 1.000) +          Fi_v( 1.000) +        SRSS11(-0.525)
     46  2             D( 1.000) +          Fh( 1.000) +              Fv( 1.000)
            +          Fhi_v( 1.000) +          Fi_v( 1.000) +         SRSS7( 0.525)
     47  2             D( 1.000) +          Fh( 1.000) +              Fv( 1.000)
            +          Fhi_v( 1.000) +          Fi_v( 1.000) +         SRSS8( 0.525)
     48  2             D( 1.000) +          Fh( 1.000) +              Fv( 1.000)
            +          Fhi_v( 1.000) +          Fi_v( 1.000) +         SRSS9( 0.525)
     49  2             D( 1.000) +          Fh( 1.000) +              Fv( 1.000)
            +          Fhi_v( 1.000) +          Fi_v( 1.000) +        SRSS10( 0.525)
     50  2             D( 1.000) +          Fh( 1.000) +              Fv( 1.000)
            +          Fhi_v( 1.000) +          Fi_v( 1.000) +         SRSS7(-0.525)
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                     Gen 2022
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      51  2              D( 1.000) +             Fh( 1.000) +             Fv( 1.000)
            +          Fhi_v( 1.000) +           Fi_v( 1.000) +           SRSS8(-0.525)
      52  2              D( 1.000) +             Fh( 1.000) +             Fv( 1.000)
            +          Fhi_v( 1.000) +           Fi_v( 1.000) +           SRSS9(-0.525)
      53  2              D( 1.000) +             Fh( 1.000) +             Fv( 1.000)
            +          Fhi_v( 1.000) +           Fi_v( 1.000) +          SRSS10(-0.525)
      54  2              D( 0.600) +          Fhi_v( 1.000) +           Fi_v( 1.000)
            +         SRSS11( 0.700)
      55  2              D( 0.600) +          Fhi_v( 1.000) +           Fi_v( 1.000)
            +         SRSS11(-0.700)
      56  2              D( 0.600) +          Fhi_v( 1.000) +           Fi_v( 1.000)
            +          SRSS7( 0.700)
      57  2              D( 0.600) +          Fhi_v( 1.000) +           Fi_v( 1.000)
            +          SRSS8( 0.700)
      58  2              D( 0.600) +          Fhi_v( 1.000) +           Fi_v( 1.000)
            +          SRSS9( 0.700)
      59  2              D( 0.600) +          Fhi_v( 1.000) +           Fi_v( 1.000)
            +         SRSS10( 0.700)
      60  2              D( 0.600) +          Fhi_v( 1.000) +           Fi_v( 1.000)
            +          SRSS7(-0.700)
      61  2              D( 0.600) +          Fhi_v( 1.000) +           Fi_v( 1.000)
            +          SRSS8(-0.700)
      62  2              D( 0.600) +          Fhi_v( 1.000) +           Fi_v( 1.000)
            +          SRSS9(-0.700)
      63  2              D( 0.600) +          Fhi_v( 1.000) +           Fi_v( 1.000)
            +         SRSS10(-0.700)
-------------------------------------------------------------------------------------
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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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      *.midas Gen - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,          *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = COLUMN ,  MEMB =     1,  LCB =   25,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     1) : C40*40
        Section Type : Rectangular with Ties (RT)
        Section Height (HTc)            =         4.000 m.
        Section Depth  (Hc)             =         0.400 m.
        Section Width  (Bc)             =         0.400 m.
        Concrete Cover to C.O.R. (do)   =         0.040 m.
        Concrete Strength (fc)          =     28000.000 KPa.
        Modulus of Elasticity (Ec)      =  24870062.324 KPa.
        Main Rebar Strength (fy)        =    420000.000 KPa.
        Ties/Spirals Strength (fys)     =    420000.000 KPa.
        Modulus of Elasticity (Es)      = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

     *.REBAR PATTERN = RT -  4 -  2 - #8          Unit :  m.
        --------------------------------------------------------
           i          dyi          dzi      Rebar          Asi
        --------------------------------------------------------
           1       -0.160       -0.160      1-#8       0.00051
           2       -0.160        0.160      1-#8       0.00051
           3        0.160        0.160      1-#8       0.00051
           4        0.160       -0.160      1-#8       0.00051
        --------------------------------------------------------

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

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =   25
           -------------------------------------------------------------------------------
            Load Case              Pu           Myi           Myj           Mzi           Mzj
           -------------------------------------------------------------------------------
            DL                 160.06         -0.37          0.63          0.33         -0.60
            LL                  -0.00          0.00          0.00          0.00          0.00
            DL+LL              160.06         -0.37          0.63          0.33         -0.60
            Others             -62.80         48.09         27.75         48.18         27.45
           -------------------------------------------------------------------------------
            DL+LL+Others        97.26         47.72         28.37         48.51         26.85
           -------------------------------------------------------------------------------
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                Gen 2022
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      ( ). Compute member end moments(M1,M2).  Unit : kN-m.
           -. For Dead Load(DL).
              My1D =         0.37,   My2D =         0.63
              Mz1D =         0.33,   Mz2D =         0.60
           -. For Gravity Load(DL+LL).
              My1G =         0.37,   My2G =         0.63
              Mz1G =         0.33,   Mz2G =         0.60
           -. For Total Load(DL+LL+WL(EL)).
              My1  =        28.37,   My2  =        47.72
              Mz1  =        26.85,   Mz2  =        48.51

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. Slenderness ratio limits.
              SRy(Braced)   =  34 - 12*| My1/My2 | =   26.865  (Single curvature)
              SRz(Braced)   =  34 - 12*| Mz1/Mz2 | =   27.358  (Single curvature)
           -. Radii of gyration.
              ry     =  0.30*Hc  =    0.120 m.
              rz     =  0.30*Bc  =    0.120 m.
           -. Unbraced lengths.
              Ly     =    4.000 m.
              Lz     =    4.000 m.
           -. Effective length factors.
              Ky     =    1.000
              Kz     =    1.000
           -. SLENy  =  Ky*Ly/ry  =   33.333  >  SRy  --->  SLENDER.
           -. SLENz  =  Kz*Lz/rz  =   33.333  >  SRz  --->  SLENDER.

      ( ). Compute moment magnification factors for major axis(DBy,DSy).
           -. Ec       =  4700*SQRT[fc]                    =  2.4870e+07 KPa.
           -. Ryy      =  Bc*Hc^3/12                       =        0.0021 m^4.
           -. Rse                                          =    5.2273e-05 m^4.
           -. Betadnsy =  Pu_D/Pu                          =   1.0000
           -. EIy      =  (0.2*Ec*Ryy+Es*Rse)/(1+Betadnsy) =    10532.8723 (by N, mm).
           -. Pu       =  Pu_G + Pu_S           =       97.26 kN.
           -. Single Curvature Bending.
           -. Cmy      =         0.85 (Default or User defined value)
           -. Pcy      =  (pi^2*EIy)/(Ky*Ly)^2  =     6497.21 kN.
           -. DBy      =  Cmy/(1-Pu/(0.75*Pcy)) =        0.87
           -. DBy  <  1.0  --->  DBy  =  1.00
           -. DSy    =     1.00 (Default value)

      ( ). Compute moment magnification factors for minor axis(DBz,DSz).
           -. Ec       =  4700*SQRT[fc]                    =  2.4870e+07 KPa.
           -. Rzz      =  Hc*Bc^3/12                       =        0.0021 m^4.
           -. Rse                                          =    5.2273e-05 m^4.
           -. Betadnsz =  Pu_D/Pu                          =   1.0000
           -. EIz      =  (0.2*Ec*Rzz+Es*Rse)/(1+Betadnsz) =    10532.8723 (by N, mm).
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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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          -. Pu       =  Pu_G + Pu_S          =       97.26 kN.
          -. Single Curvature Bending.
          -. Cmz      =        0.85 (Default or User defined value)
          -. Pcz      =  (pi^2*EIz)/(Kz*Lz)^2  =     6497.21 kN.
          -. DBz      =  Cmz/(1-Pu/(0.75*Pcz)) =        0.87
          -. DBz  <  1.0  --->  DBz  =  1.00
          -. DSz    =     1.00 (Default value)

     ( ). Compute minimum moments(Mmin).
          -. emin_y  =  15 mm. + 0.03*Hc    =       0.027 m.
          -. emin_z  =  15 mm. + 0.03*Bc    =       0.027 m.
          -. Mmin_y  =  Pu * emin_y         =        2.63 kN-m.
          -. Mmin_z  =  Pu * emin_z         =        2.63 kN-m.

     ( ). Compute magnified moments. (Pos : I, Local-y : Braced, Local-z : Braced).
          -. No sidesway moments.
             QMb_y  =  My_G   =       -0.37 kN-m.
             QMb_z  =  Mz_G   =        0.33 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       48.09 kN-m.
             QMs_z  =  Mz_S   =       48.18 kN-m.
          -. Compute magnified moments(Mcy,Mcz).
             Mcy(Slender)    =  DBy*MAX(Mmin_y, QMb_y+QMs_y)     =       47.72 kN-m.
             Mcz(Slender)    =  DBz*MAX(Mmin_z, QMb_z+QMs_z)     =       48.51 kN-m.

     ( ). Check total moment including 2nd-order effects.
          -. Moments due to 1st-order effects.
             Mcy-1st =        47.72 kN-m.
             Mcz-1st =        48.51 kN-m.
          -. Moments due to 2nd-order effects.
             Mcy-2nd = DBy*(QMb_y + QMs_y) =        47.72 kN-m.
             Mcz-2nd = DBz*(QMb_z + QMs_z) =        48.51 kN-m.
          -. Ratio of moment due to 2nd-order effects to moment due to 1st-order effects.
             Mcy-2nd / Mcy-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.
             Mcz-2nd / Mcz-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.

     ( ). Design forces/moments of column(brace).
          -. Axial Force (Compression)      Pu   =       97.26 kN.
          -. Combined Bending Moment        Mc   =       68.05 kN-m.
          -. Bending Moment about Local-y   Mcy =       47.72 kN-m.
          -. Bending Moment about Local-z   Mcz =       48.51 kN-m.
          -. Shear Force of Local-y         Vuy =       21.20 kN.
          -. Shear Force of Local-z         Vuz =       20.58 kN.

 ================================================================================
   [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC_COLUMN(RC-BRACE).
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      ( ). Compute design parameters.
           -. Ag     =              0.1600 m^2.
           -. Ast    =              0.0020 m^2.
           -. Rhot   = Ast/Ag =   0.012742
           -. esu    = fy/Es  =   0.002100
           -. beta1  =   0.8500  ( fc < 28 MPa.)

      ( ). Check the ratio of reinforcement.
           -. Rhomin =   0.010000
           -. Rhomax =   0.040000
           -. Rhot   =   0.012742
              Rhomin < Rhot < Rhomax  --->  O.K !

      ( ). Compute eccentricities of biaxially loaded column.
           -. Ecny   = ABS(Mcz/Pu)     =      0.4988 m.
           -. Ecnz   = ABS(Mcy/Pu)     =      0.4906 m.
           -. Eccn   = ABS(Mc/Pu)      =      0.6996 m.
           -. Rota   = ATAN(Ecny/Ecnz) =     45.4703 deg.
           -. Rotation of neutral axis =     45.4703 deg.

      ( ). Compute concentric axial load capacity.
           -. Po     = (0.85*fc)*(Ag-Ast) + fy*Ast    =     4615.74 kN.
           -. Maximum Axial Load    : Pomax = 0.75*Po =     3461.80 kN.
           -. Maximum Axial Tension : Pt    = -fy*Ast =     -856.26 kN.

     ----------------------------------------------------------------------------
       *. Analysis of balanced condition.
     ----------------------------------------------------------------------------

      ( ). Compute capacity of concrete stress block.
           -. cb     = (0.003/(0.003+esu))*d  =       0.299 m.
           -. ab     = beta1*cb               =       0.255 m.
           -. Acom                            =       0.065 m^2.
           -. DCcy                            =       0.081 m.
           -. DCcz                            =       0.079 m.
           -. Cc     = 0.85*fc*Acom           =     1542.34 kN.
           -. MnCy   = Cc*DCcz                =      121.86 kN-m.
           -. MnCz   = Cc*DCcy                =      124.89 kN-m.

      ( ). Compute capacity of reinforcement.
      ----------------------------------------------------------------------------------------------
       i      dsi       esi         fsi         Asi         Fsi      dzi        MnPyi      dyi       MnPzi
      ----------------------------------------------------------------------------------------------
       1    0.509 -0.002100 -420000.00  5.097e-04    -214.06   -0.160       34.25   -0.160       34.25
       2    0.285  0.000148   29611.98  5.097e-04      15.09    0.160        2.41   -0.160       -2.41
       3    0.057  0.002433  420000.00  5.097e-04     214.06    0.160       34.25    0.160       34.25
       4    0.281  0.000185   37054.69  5.097e-04      18.89   -0.160       -3.02    0.160        3.02
      ----------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ----------------------------------------------------------------------------------------------
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           -. Ps     = SUM [ Fsi ]    =       33.98 kN.
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-. MnPy   = SUM [ MnPyi ]  =       67.89 kN-m.
-. MnPz   = SUM [ MnPzi ]  =       69.11 kN-m.
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      ( ). Compute nominal capacity(Pb,Mb) of Balanced Condition.
           -. Pb      = Cc + Ps                =     1576.32 kN.
           -. Mny     = MnCy + MnPy            =      189.75 kN-m.
           -. Mnz     = MnCz + MnPz            =      194.00 kN-m.
           -. Mb      = SQRT(Mny^2+Mnz^2)      =      271.37 kN-m.

      ( ). Compare actual eccentricity with balanced eccentricity.
           -. Balanced eccentricity : eb   = Mb/Pb        =    0.172 m.
           -. Minimum eccentricity  : Emin (not defined)  =    0.000 m.
           -. Actual eccentricity   : Eccn = Mu/Pu        =    0.700 m.
           -. eb   < Eccn       --->  Tension controls.

     ----------------------------------------------------------------------------
       *. Final analysis with searched neutral axis.
     ----------------------------------------------------------------------------

      ( ). Search for neutral axis......     Unit :  kN.,  m.
           -. P-M calculation method : Keep P constant
          -----------------------------------------------------
           Trial          c       Phi*Pn        Pu       Ratio
          -----------------------------------------------------
            1-st      0.180       181.14      97.264     53.70
            2-nd      0.173       105.62      97.264     92.09
            3-rd      0.169        67.25      97.264     55.38
            4-th      0.171        86.49      97.264     87.54
            5-th      0.172        96.07      97.264     98.76
            6-th      0.173       100.85      97.264     96.45
            7-th      0.172        98.46      97.264     98.79
            8-th      0.172        97.26      97.264    100.00
            9-th      0.172        97.86      97.264     99.39
           10-th      0.172        97.56      97.264     99.69
          -----------------------------------------------------

      ( ). Compute capacity of compression stress block.
           -. a       = beta1*c                =       0.146 m.
           -. Acom                             =       0.021 m^2.
           -. DCcy                             =       0.132 m.
           -. DCcz                             =       0.130 m.
           -. Cc      = 0.85*fc*Acom           =      510.01 kN.
           -. MnCy    = Cc*DCcz                =       66.52 kN-m.
           -. MnCz    = Cc*DCcy                =       67.10 kN-m.

      ( ). Compute capacity of reinforcement.
      -------------------------------------------------------------------------------------------------
       i      dsi       esi         fsi         Asi          Fsi       dzi       MnPyi       dyi       MnPzi
      -------------------------------------------------------------------------------------------------
       1    0.509 -0.005869 -420000.00  5.097e-04    -214.06    -0.160       34.25    -0.160       34.25
       2    0.285 -0.001960 -391909.49  5.097e-04    -199.75     0.160      -31.96    -0.160       31.96
       3    0.057  0.002015  402912.40  5.097e-04     205.35     0.160       32.86     0.160       32.86
       4    0.281 -0.001895 -378966.56  5.097e-04    -193.15    -0.160       30.90     0.160      -30.90
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ---------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ----------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =     -401.61 kN.
           -. MnPy   = SUM [ MnPyi ]  =       66.05 kN-m.
           -. MnPz   = SUM [ MnPzi ]  =       68.16 kN-m.

      ( ). Compute nominal capacity(Pn,Mn) of given neutral axis.
           -. Pn     = Cc + Ps               =      108.40 kN.
           -. Mny    = MnCy + MnPy           =      132.57 kN-m.
           -. Mnz    = MnCz + MnPz           =      135.26 kN-m.
           -. Mn     = SQRT(Mny^2+Mnz^2)     =      189.39 kN-m.

      ( ). Compute strength reduction factor.
           -. et       = 0.00587
           -. et_min  = 0.00210
           -. et_max  = 0.00500
           -. et > et_max  --->  phi =0.900

      ( ). Compute axial load and moment capacities(phiPn,phiMn).
           -. phiPn  = phi*Pn  =       97.56 kN.
           -. phiMn  = phi*Mn  =      170.45 kN-m.
           -. phiMny = phi*Mny =      119.31 kN-m.
           -. phiMnz = phi*Mnz =      121.73 kN-m.

      ( ). Check ratios of axial load and moment capacity.
           -. Rat_P  = Pu/phiPn = 0.997  <  1.000  --->  O.K.
           -. Rat_M  = Mc/phiMn = 0.399  <  1.000  --->  O.K.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   25,  POS = J )
           -. Applied axial force : Pu  =       83.44 kN.
           -. Applied shear force : Vuz =       20.58 kN.
           -. d      = Hc-do    =    0.360 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      134.36 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      100.77 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.
```

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-----------------------------------------------------------------------------------------
 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   25,  POS = J )
           -. Applied axial force : Pu  =       83.44 kN.
           -. Applied shear force : Vuy =       21.20 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      134.36 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      100.77 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   25,  POS = 1/2 )
           -. Applied axial force : Pu  =       90.35 kN.
           -. Applied shear force : Vuz =       20.58 kN.
           -. d      = Hc-do    =    0.360 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      134.76 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      101.07 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   25,  POS = 1/2 )
           -. Applied axial force : Pu  =       90.35 kN.
           -. Applied shear force : Vuy =       21.20 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      134.76 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      101.07 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                              Gen 2022
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      *.midas Gen - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = COLUMN ,  MEMB =     2,  LCB =   28,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     1) : C40*40
        Section Type : Rectangular with Ties (RT)
        Section Height (HTc)            =        4.000 m.
        Section Depth  (Hc)             =        0.400 m.
        Section Width  (Bc)             =        0.400 m.
        Concrete Cover to C.O.R. (do)   =        0.040 m.
        Concrete Strength (fc)          =    28000.000 KPa.
        Modulus of Elasticity (Ec)      =  24870062.324 KPa.
        Main Rebar Strength (fy)        =   420000.000 KPa.
        Ties/Spirals Strength (fys)     =   420000.000 KPa.
        Modulus of Elasticity (Es)      = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

     *.REBAR PATTERN = RT -  4 -  2 - #8         Unit :  m.
        --------------------------------------------------------
           i          dyi          dzi      Rebar          Asi
        --------------------------------------------------------
           1       -0.160       -0.160      1-#8       0.00051
           2       -0.160        0.160      1-#8       0.00051
           3        0.160        0.160      1-#8       0.00051
           4        0.160       -0.160      1-#8       0.00051
        --------------------------------------------------------

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

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =   28
           ------------------------------------------------------------------------------
            Load Case              Pu           Myi           Myj           Mzi           Mzj
           ------------------------------------------------------------------------------
            DL                 126.50         -0.67          0.48          0.61         -0.37
            LL                  -0.00          0.00          0.00          0.00          0.00
            DL+LL              126.50         -0.67          0.48          0.61         -0.37
            Others              10.14         38.39         38.27         38.17         38.75
           ------------------------------------------------------------------------------
            DL+LL+Others       136.63         37.72         38.75         38.78         38.38
           ------------------------------------------------------------------------------
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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      ( ). Compute member end moments(M1,M2).  Unit : kN-m.
           -. For Dead Load(DL).
              My1D =          0.48,   My2D =         0.67
              Mz1D =          0.37,   Mz2D =         0.61
           -. For Gravity Load(DL+LL).
              My1G =          0.48,   My2G =         0.67
              Mz1G =          0.37,   Mz2G =         0.61
           -. For Total Load(DL+LL+WL(EL)).
              My1  =         37.72,   My2  =        38.75
              Mz1  =         38.38,   Mz2  =        38.78

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. Slenderness ratio limits.
              SRy(Braced)   =  34 - 12*| My1/My2 | =   22.319  (Single curvature)
              SRz(Braced)   =  34 - 12*| Mz1/Mz2 | =   22.124  (Single curvature)
           -. Radii of gyration.
              ry     =  0.30*Hc  =    0.120 m.
              rz     =  0.30*Bc  =    0.120 m.
           -. Unbraced lengths.
              Ly     =    4.000 m.
              Lz     =    4.000 m.
           -. Effective length factors.
              Ky     =    1.000
              Kz     =    1.000
           -. SLENy  =  Ky*Ly/ry  =   33.333  >  SRy  --->  SLENDER.
           -. SLENz  =  Kz*Lz/rz  =   33.333  >  SRz  --->  SLENDER.

      ( ). Compute moment magnification factors for major axis(DBy,DSy).
           -. Ec       =  4700*SQRT[fc]                    =  2.4870e+07 KPa.
           -. Ryy      =  Bc*Hc^3/12                       =        0.0021 m^4.
           -. Rse                                          =    5.2273e-05 m^4.
           -. Betadnsy =  Pu_D/Pu                          =   0.9258
           -. EIy      =  (0.2*Ec*Ryy+Es*Rse)/(1+Betadnsy) =    10938.6334 (by N, mm).
           -. Pu       =  Pu_G + Pu_S           =       136.63 kN.
           -. Single Curvature Bending.
           -. Cmy      =        0.85 (Default or User defined value)
           -. Pcy      =  (pi^2*EIy)/(Ky*Ly)^2  =     6747.50 kN.
           -. DBy      =  Cmy/(1-Pu/(0.75*Pcy)) =        0.87
           -. DBy  <  1.0  --->  DBy  =  1.00
           -. DSy    =     1.00 (Default value)

      ( ). Compute moment magnification factors for minor axis(DBz,DSz).
           -. Ec       =  4700*SQRT[fc]                    =  2.4870e+07 KPa.
           -. Rzz      =  Hc*Bc^3/12                       =        0.0021 m^4.
           -. Rse                                          =    5.2273e-05 m^4.
           -. Betadnsz =  Pu_D/Pu                          =   0.9258
           -. EIz      =  (0.2*Ec*Rzz+Es*Rse)/(1+Betadnsz) =    10938.6334 (by N, mm).
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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           -. Pu       =  Pu_G + Pu_S           =      136.63 kN.
           -. Single Curvature Bending.
           -. Cmz      =        0.85 (Default or User defined value)
           -. Pcz      =  (pi^2*EIz)/(Kz*Lz)^2  =     6747.50 kN.
           -. DBz      =  Cmz/(1-Pu/(0.75*Pcz)) =        0.87
           -. DBz  <  1.0  --->  DBz  =  1.00
           -. DSz    =     1.00 (Default value)

      ( ). Compute minimum moments(Mmin).
           -. emin_y  =  15 mm. + 0.03*Hc    =       0.027 m.
           -. emin_z  =  15 mm. + 0.03*Bc    =       0.027 m.
           -. Mmin_y  =  Pu * emin_y         =        3.69 kN-m.
           -. Mmin_z  =  Pu * emin_z         =        3.69 kN-m.

      ( ). Compute magnified moments. (Pos : J, Local-y : Braced, Local-z : Braced).
           -. No sidesway moments.
              QMb_y  =  My_G   =        0.48 kN-m.
              QMb_z  =  Mz_G   =       -0.37 kN-m.
           -. Sidesway moments.
              QMs_y  =  My_S   =       38.27 kN-m.
              QMs_z  =  Mz_S   =       38.75 kN-m.
           -. Compute magnified moments(Mcy,Mcz).
              Mcy(Slender)    =  DBy*MAX(Mmin_y, QMb_y+QMs_y)     =       38.75 kN-m.
              Mcz(Slender)    =  DBz*MAX(Mmin_z, QMb_z+QMs_z)     =       38.38 kN-m.

      ( ). Check total moment including 2nd-order effects.
           -. Moments due to 1st-order effects.
              Mcy-1st =        38.75 kN-m.
              Mcz-1st =        38.38 kN-m.
           -. Moments due to 2nd-order effects.
              Mcy-2nd = DBy*(QMb_y + QMs_y) =        38.75 kN-m.
              Mcz-2nd = DBz*(QMb_z + QMs_z) =        38.38 kN-m.
           -. Ratio of moment due to 2nd-order effects to moment due to 1st-order effects.
              Mcy-2nd / Mcy-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.
              Mcz-2nd / Mcz-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.

      ( ). Design forces/moments of column(brace).
           -. Axial Force (Compression)      Pu   =      136.63 kN.
           -. Combined Bending Moment        Mc   =       54.54 kN-m.
           -. Bending Moment about Local-y   Mcy =       38.75 kN-m.
           -. Bending Moment about Local-z   Mcz =       38.38 kN-m.
           -. Shear Force of Local-y         Vuy =       21.20 kN.
           -. Shear Force of Local-z         Vuz =       20.88 kN.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC_COLUMN(RC-BRACE).
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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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      ( ). Compute design parameters.
           -. Ag     =              0.1600 m^2.
           -. Ast    =              0.0020 m^2.
           -. Rhot   = Ast/Ag =   0.012742
           -. esu    = fy/Es  =   0.002100
           -. beta1  =   0.8500  ( fc < 28 MPa.)

      ( ). Check the ratio of reinforcement.
           -. Rhomin =   0.010000
           -. Rhomax =   0.040000
           -. Rhot   =   0.012742
              Rhomin < Rhot < Rhomax  --->  O.K !

      ( ). Compute eccentricities of biaxially loaded column.
           -. Ecny   = ABS(Mcz/Pu)     =      0.2809 m.
           -. Ecnz   = ABS(Mcy/Pu)     =      0.2836 m.
           -. Eccn   = ABS(Mc/Pu)      =      0.3992 m.
           -. Rota   = ATAN(Ecny/Ecnz) =     44.7251 deg.
           -. Rotation of neutral axis =     44.7251 deg.

      ( ). Compute concentric axial load capacity.
           -. Po     = (0.85*fc)*(Ag-Ast) + fy*Ast    =     4615.74 kN.
           -. Maximum Axial Load    : Pomax = 0.75*Po =     3461.80 kN.
           -. Maximum Axial Tension : Pt    = -fy*Ast =     -856.26 kN.

     ----------------------------------------------------------------------------
       *. Analysis of balanced condition.
     ----------------------------------------------------------------------------

      ( ). Compute capacity of concrete stress block.
           -. cb     = (0.003/(0.003+esu))*d  =       0.299 m.
           -. ab     = beta1*cb               =       0.255 m.
           -. Acom                            =       0.065 m^2.
           -. DCcy                            =       0.079 m.
           -. DCcz                            =       0.081 m.
           -. Cc     = 0.85*fc*Acom           =     1542.28 kN.
           -. MnCy   = Cc*DCcz                =      124.27 kN-m.
           -. MnCz   = Cc*DCcy                =      122.49 kN-m.

      ( ). Compute capacity of reinforcement.
```

i	dsi	esi	fsi	Asi	Fsi	dzi	MnPyi	dyi	MnPzi
1	0.509	-0.002100	-420000.00	5.097e-04	-214.06	-0.160	34.25	-0.160	34.25
2	0.282	0.000178	35508.55	5.097e-04	18.10	0.160	2.90	-0.160	-2.90
3	0.057	0.002433	420000.00	5.097e-04	214.06	0.160	34.25	0.160	34.25
4	0.284	0.000156	31158.12	5.097e-04	15.88	-0.160	-2.54	0.160	2.54

```
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-axis ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-axis ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      -----------------------------------------------------------------------------------------------------------
           -. Ps     = SUM [ Fsi ]    =       33.98 kN.
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-. MnPy   = SUM [ MnPyi ]  =       68.86 kN-m.
-. MnPz   = SUM [ MnPzi ]  =       68.15 kN-m.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                Gen 2022
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      ( ). Compute nominal capacity(Pb,Mb) of Balanced Condition.
           -. Pb     = Cc + Ps               =     1576.25 kN.
           -. Mny    = MnCy + MnPy           =      193.12 kN-m.
           -. Mnz    = MnCz + MnPz           =      190.64 kN-m.
           -. Mb     = SQRT(Mny^2+Mnz^2)     =      271.36 kN-m.

      ( ). Compare actual eccentricity with balanced eccentricity.
           -. Balanced eccentricity : eb   = Mb/Pb        =    0.172 m.
           -. Minimum eccentricity  : Emin (not defined)  =    0.000 m.
           -. Actual eccentricity   : Eccn = Mu/Pu        =    0.399 m.
           -. eb   < Eccn       --->  Tension controls.

     ----------------------------------------------------------------------------
       *. Final analysis with searched neutral axis.
     ----------------------------------------------------------------------------

      ( ). Search for neutral axis......     Unit :  kN.,  m.
           -. P-M calculation method : Keep P constant
          ------------------------------------------------------
           Trial          c       Phi*Pn       Pu       Ratio
          ------------------------------------------------------
            1-st      0.180       181.11     136.632     75.44
            2-nd      0.173       105.60     136.632     70.61
            3-rd      0.176       143.54     136.632     95.19
            4-th      0.175       124.62     136.632     90.36
            5-th      0.176       134.09     136.632     98.11
            6-th      0.176       138.82     136.632     98.42
            7-th      0.176       136.46     136.632     99.87
            8-th      0.176       137.64     136.632     99.27
            9-th      0.176       137.05     136.632     99.70
          ------------------------------------------------------

      ( ). Compute capacity of compression stress block.
           -. a      = beta1*c               =       0.149 m.
           -. Acom                           =       0.022 m^2.
           -. DCcy                           =       0.129 m.
           -. DCcz                           =       0.130 m.
           -. Cc     = 0.85*fc*Acom          =      531.40 kN.
           -. MnCy   = Cc*DCcz               =       69.03 kN-m.
           -. MnCz   = Cc*DCcy               =       68.67 kN-m.

      ( ). Compute capacity of reinforcement.
      -------------------------------------------------------------------------------------------------
      i      dsi       esi         fsi         Asi          Fsi      dzi       MnPyi      dyi       MnPzi
      -------------------------------------------------------------------------------------------------
      1    0.509 -0.005688 -420000.00  5.097e-04    -214.06   -0.160       34.25   -0.160       34.25
      2    0.282 -0.001808 -361677.32  5.097e-04    -184.34    0.160      -29.49   -0.160       29.49
      3    0.057  0.002035  406923.39  5.097e-04     207.40    0.160       33.18    0.160       33.18
      4    0.284 -0.001845 -369088.80  5.097e-04    -188.12   -0.160       30.10    0.160      -30.10
```

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-------------------------------------------------------------------------------------------
 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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      ---------------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ----------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =     -379.12 kN.
           -. MnPy   = SUM [ MnPyi ]  =       68.04 kN-m.
           -. MnPz   = SUM [ MnPzi ]  =       66.83 kN-m.

      ( ). Compute nominal capacity(Pn,Mn) of given neutral axis.
           -. Pn     = Cc + Ps               =      152.28 kN.
           -. Mny    = MnCy + MnPy           =      137.07 kN-m.
           -. Mnz    = MnCz + MnPz           =      135.50 kN-m.
           -. Mn     = SQRT(Mny^2+Mnz^2)     =      192.73 kN-m.

      ( ). Compute strength reduction factor.
           -. et      = 0.00569
           -. et_min  = 0.00210
           -. et_max  = 0.00500
           -. et > et_max  --->  phi =0.900

      ( ). Compute axial load and moment capacities(phiPn,phiMn).
           -. phiPn  = phi*Pn  =      137.05 kN.
           -. phiMn  = phi*Mn  =      173.46 kN-m.
           -. phiMny = phi*Mny =      123.36 kN-m.
           -. phiMnz = phi*Mnz =      121.95 kN-m.

      ( ). Check ratios of axial load and moment capacity.
           -. Rat_P  = Pu/phiPn = 0.997  <  1.000  --->  O.K.
           -. Rat_M  = Mc/phiMn = 0.314  <  1.000  --->  O.K.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   25,  POS = J )
           -. Applied axial force : Pu  =      136.63 kN.
           -. Applied shear force : Vuz =       20.88 kN.
           -. d      = Hc-do    =    0.360 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      137.44 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      103.08 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                    Gen 2022
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      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   25,  POS = J )
           -. Applied axial force : Pu  =      136.63 kN.
           -. Applied shear force : Vuy =       21.20 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      137.44 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      103.08 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   25,  POS = 1/2 )
           -. Applied axial force : Pu  =      143.54 kN.
           -. Applied shear force : Vuz =       20.88 kN.
           -. d      = Hc-do    =    0.360 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      137.84 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      103.38 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   25,  POS = 1/2 )
           -. Applied axial force : Pu  =      143.54 kN.
           -. Applied shear force : Vuy =       21.20 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      137.84 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      103.38 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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      *.midas Gen - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = COLUMN ,  MEMB =     3,  LCB =   25,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     1) : C40*40
        Section Type : Rectangular with Ties (RT)
        Section Height (HTc)            =        4.000 m.
        Section Depth  (Hc)             =        0.400 m.
        Section Width  (Bc)             =        0.400 m.
        Concrete Cover to C.O.R. (do)   =        0.040 m.
        Concrete Strength (fc)          =    28000.000 KPa.
        Modulus of Elasticity (Ec)      =  24870062.324 KPa.
        Main Rebar Strength (fy)        =   420000.000 KPa.
        Ties/Spirals Strength (fys)     =   420000.000 KPa.
        Modulus of Elasticity (Es)      = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

     *.REBAR PATTERN = RT -  4 -  2 - #8          Unit :  m.
        --------------------------------------------------------
           i          dyi          dzi      Rebar          Asi
        --------------------------------------------------------
           1       -0.160       -0.160      1-#8       0.00051
           2       -0.160        0.160      1-#8       0.00051
           3        0.160        0.160      1-#8       0.00051
           4        0.160       -0.160      1-#8       0.00051
        --------------------------------------------------------

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

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =   25
           ------------------------------------------------------------------------------
            Load Case               Pu          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                  105.98        -1.41         2.34         1.49        -2.44
            LL                   -0.00         0.00         0.00         0.00         0.00
            DL+LL               105.98        -1.41         2.34         1.49        -2.44
            Others               79.81        24.80        45.78        27.20        40.84
           ------------------------------------------------------------------------------
            DL+LL+Others        185.79        23.39        48.12        28.69        38.40
           ------------------------------------------------------------------------------
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute member end moments(M1,M2).  Unit : kN-m.
           -. For Dead Load(DL).
              My1D =         1.41,   My2D =         2.34
              Mz1D =         1.49,   Mz2D =         2.44
           -. For Gravity Load(DL+LL).
              My1G =         1.41,   My2G =         2.34
              Mz1G =         1.49,   Mz2G =         2.44
           -. For Total Load(DL+LL+WL(EL)).
              My1  =        23.39,   My2  =        48.12
              Mz1  =        28.69,   Mz2  =        38.40

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. Slenderness ratio limits.
              SRy(Braced)   =  34 - 12*| My1/My2 | =   28.167  (Single curvature)
              SRz(Braced)   =  34 - 12*| Mz1/Mz2 | =   25.035  (Single curvature)
           -. Radii of gyration.
              ry     =  0.30*Hc  =    0.120 m.
              rz     =  0.30*Bc  =    0.120 m.
           -. Unbraced lengths.
              Ly     =    4.000 m.
              Lz     =    4.000 m.
           -. Effective length factors.
              Ky     =    1.000
              Kz     =    1.000
           -. SLENy  =  Ky*Ly/ry  =   33.333  >  SRy  --->  SLENDER.
           -. SLENz  =  Kz*Lz/rz  =   33.333  >  SRz  --->  SLENDER.

      ( ). Compute moment magnification factors for major axis(DBy,DSy).
           -. Ec       =  4700*SQRT[fc]                    =  2.4870e+07 KPa.
           -. Ryy      =  Bc*Hc^3/12                       =        0.0021 m^4.
           -. Rse                                          =    5.2273e-05 m^4.
           -. Betadnsy =  Pu_D/Pu                          =   0.5704
           -. EIy      =  (0.2*Ec*Ryy+Es*Rse)/(1+Betadnsy) =    13413.9420 (by N, mm).
           -. Pu       =  Pu_G + Pu_S           =       185.79 kN.
           -. Single Curvature Bending.
           -. Cmy      =        0.85 (Default or User defined value)
           -. Pcy      =  (pi^2*EIy)/(Ky*Ly)^2  =     8274.39 kN.
           -. DBy      =  Cmy/(1-Pu/(0.75*Pcy)) =        0.88
           -. DBy  <  1.0  --->  DBy  =  1.00
           -. DSy    =     1.00 (Default value)

      ( ). Compute moment magnification factors for minor axis(DBz,DSz).
           -. Ec       =  4700*SQRT[fc]                    =  2.4870e+07 KPa.
           -. Rzz      =  Hc*Bc^3/12                       =        0.0021 m^4.
           -. Rse                                          =    5.2273e-05 m^4.
           -. Betadnsz =  Pu_D/Pu                          =   0.5704
           -. EIz      =  (0.2*Ec*Rzz+Es*Rse)/(1+Betadnsz) =    13413.9420 (by N, mm).
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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           -. Pu       =  Pu_G + Pu_S           =      185.79 kN.
           -. Single Curvature Bending.
           -. Cmz      =        0.85 (Default or User defined value)
           -. Pcz      =  (pi^2*EIz)/(Kz*Lz)^2  =     8274.39 kN.
           -. DBz      =  Cmz/(1-Pu/(0.75*Pcz)) =        0.88
           -. DBz  <  1.0  --->  DBz  =  1.00
           -. DSz    =     1.00 (Default value)

      ( ). Compute minimum moments(Mmin).
           -. emin_y  =  15 mm. + 0.03*Hc    =       0.027 m.
           -. emin_z  =  15 mm. + 0.03*Bc    =       0.027 m.
           -. Mmin_y  =  Pu * emin_y         =        5.02 kN-m.
           -. Mmin_z  =  Pu * emin_z         =        5.02 kN-m.

      ( ). Compute magnified moments. (Pos : J, Local-y : Braced, Local-z : Braced).
           -. No sidesway moments.
              QMb_y  =  My_G   =        2.34 kN-m.
              QMb_z  =  Mz_G   =       -2.44 kN-m.
           -. Sidesway moments.
              QMs_y  =  My_S   =       45.78 kN-m.
              QMs_z  =  Mz_S   =       40.84 kN-m.
           -. Compute magnified moments(Mcy,Mcz).
              Mcy(Slender)    =  DBy*MAX(Mmin_y, QMb_y+QMs_y)     =       48.12 kN-m.
              Mcz(Slender)    =  DBz*MAX(Mmin_z, QMb_z+QMs_z)     =       38.40 kN-m.

      ( ). Check total moment including 2nd-order effects.
           -. Moments due to 1st-order effects.
              Mcy-1st =        48.12 kN-m.
              Mcz-1st =        38.40 kN-m.
           -. Moments due to 2nd-order effects.
              Mcy-2nd = DBy*(QMb_y + QMs_y) =        48.12 kN-m.
              Mcz-2nd = DBz*(QMb_z + QMs_z) =        38.40 kN-m.
           -. Ratio of moment due to 2nd-order effects to moment due to 1st-order effects.
              Mcy-2nd / Mcy-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.
              Mcz-2nd / Mcz-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.

      ( ). Design forces/moments of column(brace).
           -. Axial Force (Compression)      Pu   =      185.79 kN.
           -. Combined Bending Moment        Mc   =       61.56 kN-m.
           -. Bending Moment about Local-y   Mcy =       48.12 kN-m.
           -. Bending Moment about Local-z   Mcz =       38.40 kN-m.
           -. Shear Force of Local-y         Vuy =       21.70 kN.
           -. Shear Force of Local-z         Vuz =       21.53 kN.

 ================================================================================
   [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC_COLUMN(RC-BRACE).
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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute design parameters.
           -. Ag     =              0.1600 m^2.
           -. Ast    =              0.0020 m^2.
           -. Rhot   = Ast/Ag =   0.012742
           -. esu    = fy/Es  =   0.002100
           -. beta1  =   0.8500  ( fc < 28 MPa.)

      ( ). Check the ratio of reinforcement.
           -. Rhomin =   0.010000
           -. Rhomax =   0.040000
           -. Rhot   =   0.012742
              Rhomin < Rhot < Rhomax  --->  O.K !

      ( ). Compute eccentricities of biaxially loaded column.
           -. Ecny   = ABS(Mcz/Pu)     =      0.2067 m.
           -. Ecnz   = ABS(Mcy/Pu)     =      0.2590 m.
           -. Eccn   = ABS(Mc/Pu)      =      0.3314 m.
           -. Rota   = ATAN(Ecny/Ecnz) =     38.5893 deg.
           -. Rotation of neutral axis =     38.5893 deg.

      ( ). Compute concentric axial load capacity.
           -. Po     = (0.85*fc)*(Ag-Ast) + fy*Ast    =     4615.74 kN.
           -. Maximum Axial Load    : Pomax = 0.75*Po =     3461.80 kN.
           -. Maximum Axial Tension : Pt    = -fy*Ast =     -856.26 kN.

     ----------------------------------------------------------------------------
       *. Analysis of balanced condition.
     ----------------------------------------------------------------------------

      ( ). Compute capacity of concrete stress block.
           -. cb     = (0.003/(0.003+esu))*d  =       0.298 m.
           -. ab     = beta1*cb               =       0.253 m.
           -. Acom                            =       0.066 m^2.
           -. DCcy                            =       0.065 m.
           -. DCcz                            =       0.092 m.
           -. Cc     = 0.85*fc*Acom           =     1561.66 kN.
           -. MnCy   = Cc*DCcz                =      143.83 kN-m.
           -. MnCz   = Cc*DCcy                =      101.29 kN-m.

      ( ). Compute capacity of reinforcement.
      ------------------------------------------------------------------------------------------------
       i      dsi       esi         fsi         Asi         Fsi      dzi        MnPyi      dyi       MnPzi
      ------------------------------------------------------------------------------------------------
       1    0.506 -0.002100 -420000.00  5.097e-04    -214.06   -0.160       34.25   -0.160       34.25
       2    0.256  0.000421   84268.33  5.097e-04      42.95    0.160        6.87   -0.160       -6.87
       3    0.056  0.002433  420000.00  5.097e-04     214.06    0.160       34.25    0.160       34.25
       4    0.306 -0.000088  -17601.66  5.097e-04      -8.97   -0.160        1.44    0.160       -1.44
      ------------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =       33.98 kN.
```

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-. MnPy   = SUM [ MnPyi ]  =       76.81 kN-m.
-. MnPz   = SUM [ MnPzi ]  =       60.19 kN-m.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                   Gen 2022
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      ( ). Compute nominal capacity(Pb,Mb) of Balanced Condition.
           -. Pb     = Cc + Ps                =     1595.64 kN.
           -. Mny    = MnCy + MnPy            =      220.64 kN-m.
           -. Mnz    = MnCz + MnPz            =      161.48 kN-m.
           -. Mb     = SQRT(Mny^2+Mnz^2)      =      273.42 kN-m.

      ( ). Compare actual eccentricity with balanced eccentricity.
           -. Balanced eccentricity : eb   = Mb/Pb        =    0.171 m.
           -. Minimum eccentricity  : Emin (not defined)  =    0.000 m.
           -. Actual eccentricity   : Eccn = Mu/Pu        =    0.331 m.
           -. eb   < Eccn       --->  Tension controls.

     ---------------------------------------------------------------------------
       *. Final analysis with searched neutral axis.
     ---------------------------------------------------------------------------

      ( ). Search for neutral axis......     Unit :  kN.,  m.
           -. P-M calculation method : Keep P constant
          -----------------------------------------------------
           Trial          c       Phi*Pn       Pu       Ratio
          -----------------------------------------------------
            1-st      0.179       191.42     185.787     97.06
            2-nd      0.172       134.21     185.787     61.57
            3-rd      0.175       162.82     185.787     85.89
            4-th      0.177       177.12     185.787     95.11
            5-th      0.178       184.27     185.787     99.18
            6-th      0.178       187.85     185.787     98.90
            7-th      0.178       186.06     185.787     99.85
          -----------------------------------------------------

      ( ). Compute capacity of compression stress block.
           -. a      = beta1*c                =       0.151 m.
           -. Acom                            =       0.023 m^2.
           -. DCcy                            =       0.119 m.
           -. DCcz                            =       0.135 m.
           -. Cc     = 0.85*fc*Acom           =      559.13 kN.
           -. MnCy   = Cc*DCcz                =       75.74 kN-m.
           -. MnCz   = Cc*DCcy                =       66.60 kN-m.

      ( ). Compute capacity of reinforcement.
      -----------------------------------------------------------------------------------------------
       i      dsi       esi         fsi        Asi         Fsi      dzi        MnPyi      dyi       MnPzi
      -----------------------------------------------------------------------------------------------
       1    0.506 -0.005524 -420000.00  5.097e-04    -214.06   -0.160       34.25   -0.160       34.25
       2    0.256 -0.001310 -261989.99  5.097e-04    -133.53    0.160      -21.36   -0.160       21.36
       3    0.056  0.002053  410575.53  5.097e-04     209.26    0.160       33.48    0.160       33.48
       4    0.306 -0.002161 -420000.00  5.097e-04    -214.06   -0.160       34.25    0.160      -34.25
      -----------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ---------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =     -352.40 kN.
```

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-. MnPy   = SUM [ MnPyi ]  =       80.62 kN-m.
-. MnPz   = SUM [ MnPzi ]  =       54.85 kN-m.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                              Gen 2022
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      ( ). Compute nominal capacity(Pn,Mn) of given neutral axis.
           -. Pn     = Cc + Ps               =      206.73 kN.
           -. Mny    = MnCy + MnPy           =      156.35 kN-m.
           -. Mnz    = MnCz + MnPz           =      121.45 kN-m.
           -. Mn     = SQRT(Mny^2+Mnz^2)     =      197.98 kN-m.

      ( ). Compute strength reduction factor.
           -. et      = 0.00552
           -. et_min  = 0.00210
           -. et_max  = 0.00500
           -. et > et_max  --->  phi =0.900

      ( ). Compute axial load and moment capacities(phiPn,phiMn).
           -. phiPn  = phi*Pn  =      186.06 kN.
           -. phiMn  = phi*Mn  =      178.18 kN-m.
           -. phiMny = phi*Mny =      140.72 kN-m.
           -. phiMnz = phi*Mnz =      109.30 kN-m.

      ( ). Check ratios of axial load and moment capacity.
           -. Rat_P  = Pu/phiPn = 0.999  <  1.000  --->  O.K.
           -. Rat_M  = Mc/phiMn = 0.346  <  1.000  --->  O.K.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   22,  POS = J )
           -. Applied axial force : Pu  =      241.77 kN.
           -. Applied shear force : Vuz =       21.53 kN.
           -. d      = Hc-do     =    0.360 m.
           -. Bw     = Bc        =    0.400 m.
           -. Acv    = Bw*d      =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      143.52 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc    =      107.64 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   18,  POS = J )
           -. Applied axial force : Pu  =      221.12 kN.
           -. Applied shear force : Vuy =       21.70 kN.
           -. d      = Bc-do     =    0.360 m.
           -. Bw     = Hc        =    0.400 m.
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 midas Gen - RC-Column Design   [ NSR-10 ]                                        Gen 2022
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           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      142.32 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      106.74 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   22,  POS = 1/2 )
           -. Applied axial force : Pu  =      250.99 kN.
           -. Applied shear force : Vuz =       21.53 kN.
           -. d      = Hc-do    =    0.360 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      144.05 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      108.04 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   18,  POS = 1/2 )
           -. Applied axial force : Pu  =      230.33 kN.
           -. Applied shear force : Vuy =       21.70 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      142.86 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      107.14 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      *.midas Gen - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = COLUMN ,  MEMB =     4,  LCB =   27,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     1) : C40*40
        Section Type : Rectangular with Ties (RT)
        Section Height (HTc)            =         4.000 m.
        Section Depth  (Hc)             =         0.400 m.
        Section Width  (Bc)             =         0.400 m.
        Concrete Cover to C.O.R. (do)   =         0.040 m.
        Concrete Strength (fc)          =     28000.000 KPa.
        Modulus of Elasticity (Ec)      =  24870062.324 KPa.
        Main Rebar Strength (fy)        =    420000.000 KPa.
        Ties/Spirals Strength (fys)     =    420000.000 KPa.
        Modulus of Elasticity (Es)      = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

     *.REBAR PATTERN = RT -  4 -  2 - #8          Unit :  m.
        --------------------------------------------------------
           i          dyi          dzi      Rebar          Asi
        --------------------------------------------------------
           1       -0.160       -0.160      1-#8       0.00051
           2       -0.160        0.160      1-#8       0.00051
           3        0.160        0.160      1-#8       0.00051
           4        0.160       -0.160      1-#8       0.00051
        --------------------------------------------------------

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

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =   27
           -------------------------------------------------------------------------------
            Load Case              Pu           Myi           Myj           Mzi           Mzj
           -------------------------------------------------------------------------------
            DL                 158.75         -0.33          0.60         -0.35          0.61
            LL                  -0.00          0.00          0.00          0.00          0.00
            DL+LL              158.75         -0.33          0.60         -0.35          0.61
            Others             -61.84         48.07         27.70         48.06         27.73
           -------------------------------------------------------------------------------
            DL+LL+Others        96.91         47.74         28.30         47.71         28.34
           -------------------------------------------------------------------------------
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute member end moments(M1,M2).  Unit : kN-m.
           -. For Dead Load(DL).
              My1D =         0.33,   My2D =         0.60
              Mz1D =         0.35,   Mz2D =         0.61
           -. For Gravity Load(DL+LL).
              My1G =         0.33,   My2G =         0.60
              Mz1G =         0.35,   Mz2G =         0.61
           -. For Total Load(DL+LL+WL(EL)).
              My1  =        28.30,   My2  =        47.74
              Mz1  =        28.34,   Mz2  =        47.71

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. Slenderness ratio limits.
              SRy(Braced)   =  34 - 12*| My1/My2 | =   26.886  (Single curvature)
              SRz(Braced)   =  34 - 12*| Mz1/Mz2 | =   26.871  (Single curvature)
           -. Radii of gyration.
              ry     =  0.30*Hc  =    0.120 m.
              rz     =  0.30*Bc  =    0.120 m.
           -. Unbraced lengths.
              Ly     =    4.000 m.
              Lz     =    4.000 m.
           -. Effective length factors.
              Ky     =    1.000
              Kz     =    1.000
           -. SLENy  =  Ky*Ly/ry  =   33.333  >  SRy  --->  SLENDER.
           -. SLENz  =  Kz*Lz/rz  =   33.333  >  SRz  --->  SLENDER.

      ( ). Compute moment magnification factors for major axis(DBy,DSy).
           -. Ec       =  4700*SQRT[fc]                    =  2.4870e+07 KPa.
           -. Ryy      =  Bc*Hc^3/12                       =        0.0021 m^4.
           -. Rse                                          =    5.2273e-05 m^4.
           -. Betadnsy =  Pu_D/Pu                          =   1.0000
           -. EIy      =  (0.2*Ec*Ryy+Es*Rse)/(1+Betadnsy) =    10532.8723 (by N, mm).
           -. Pu       =  Pu_G + Pu_S            =       96.91 kN.
           -. Single Curvature Bending.
           -. Cmy      =         0.85 (Default or User defined value)
           -. Pcy      =  (pi^2*EIy)/(Ky*Ly)^2  =     6497.21 kN.
           -. DBy      =  Cmy/(1-Pu/(0.75*Pcy)) =        0.87
           -. DBy  <  1.0  --->  DBy  =  1.00
           -. DSy    =     1.00 (Default value)

      ( ). Compute moment magnification factors for minor axis(DBz,DSz).
           -. Ec       =  4700*SQRT[fc]                    =  2.4870e+07 KPa.
           -. Rzz      =  Hc*Bc^3/12                       =        0.0021 m^4.
           -. Rse                                          =    5.2273e-05 m^4.
           -. Betadnsz =  Pu_D/Pu                          =   1.0000
           -. EIz      =  (0.2*Ec*Rzz+Es*Rse)/(1+Betadnsz) =    10532.8723 (by N, mm).
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                   Gen 2022
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          -. Pu       =  Pu_G + Pu_S           =       96.91 kN.
          -. Single Curvature Bending.
          -. Cmz      =        0.85 (Default or User defined value)
          -. Pcz      =  (pi^2*EIz)/(Kz*Lz)^2  =     6497.21 kN.
          -. DBz      =  Cmz/(1-Pu/(0.75*Pcz)) =        0.87
          -. DBz  <  1.0  --->  DBz  =  1.00
          -. DSz    =     1.00 (Default value)

     ( ). Compute minimum moments(Mmin).
          -. emin_y  =  15 mm. + 0.03*Hc    =       0.027 m.
          -. emin_z  =  15 mm. + 0.03*Bc    =       0.027 m.
          -. Mmin_y  =  Pu * emin_y         =        2.62 kN-m.
          -. Mmin_z  =  Pu * emin_z         =        2.62 kN-m.

     ( ). Compute magnified moments. (Pos : I, Local-y : Braced, Local-z : Braced).
          -. No sidesway moments.
             QMb_y  =  My_G   =       -0.33 kN-m.
             QMb_z  =  Mz_G   =       -0.35 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       48.07 kN-m.
             QMs_z  =  Mz_S   =       48.06 kN-m.
          -. Compute magnified moments(Mcy,Mcz).
             Mcy(Slender)    =  DBy*MAX(Mmin_y, QMb_y+QMs_y)     =       47.74 kN-m.
             Mcz(Slender)    =  DBz*MAX(Mmin_z, QMb_z+QMs_z)     =       47.71 kN-m.

     ( ). Check total moment including 2nd-order effects.
          -. Moments due to 1st-order effects.
             Mcy-1st =        47.74 kN-m.
             Mcz-1st =        47.71 kN-m.
          -. Moments due to 2nd-order effects.
             Mcy-2nd = DBy*(QMb_y + QMs_y) =        47.74 kN-m.
             Mcz-2nd = DBz*(QMb_z + QMs_z) =        47.71 kN-m.
          -. Ratio of moment due to 2nd-order effects to moment due to 1st-order effects.
             Mcy-2nd / Mcy-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.
             Mcz-2nd / Mcz-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.

     ( ). Design forces/moments of column(brace).
          -. Axial Force (Compression)      Pu   =       96.91 kN.
          -. Combined Bending Moment        Mc   =       67.49 kN-m.
          -. Bending Moment about Local-y   Mcy =       47.74 kN-m.
          -. Bending Moment about Local-z   Mcz =       47.71 kN-m.
          -. Shear Force of Local-y         Vuy =       20.58 kN.
          -. Shear Force of Local-z         Vuz =       20.59 kN.

 ================================================================================
   [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC_COLUMN(RC-BRACE).
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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute design parameters.
           -. Ag     =              0.1600 m^2.
           -. Ast    =              0.0020 m^2.
           -. Rhot   = Ast/Ag =   0.012742
           -. esu    = fy/Es  =   0.002100
           -. beta1  =   0.8500  ( fc < 28 MPa.)

      ( ). Check the ratio of reinforcement.
           -. Rhomin =   0.010000
           -. Rhomax =   0.040000
           -. Rhot   =   0.012742
              Rhomin < Rhot < Rhomax  --->  O.K !

      ( ). Compute eccentricities of biaxially loaded column.
           -. Ecny   = ABS(Mcz/Pu)     =      0.4923 m.
           -. Ecnz   = ABS(Mcy/Pu)     =      0.4927 m.
           -. Eccn   = ABS(Mc/Pu)      =      0.6965 m.
           -. Rota   = ATAN(Ecny/Ecnz) =     44.9783 deg.
           -. Rotation of neutral axis =     44.9783 deg.

      ( ). Compute concentric axial load capacity.
           -. Po     = (0.85*fc)*(Ag-Ast) + fy*Ast    =     4615.74 kN.
           -. Maximum Axial Load    : Pomax = 0.75*Po =     3461.80 kN.
           -. Maximum Axial Tension : Pt    = -fy*Ast =     -856.26 kN.

     ----------------------------------------------------------------------------
       *. Analysis of balanced condition.
     ----------------------------------------------------------------------------

      ( ). Compute capacity of concrete stress block.
           -. cb     = (0.003/(0.003+esu))*d  =       0.299 m.
           -. ab     = beta1*cb               =       0.255 m.
           -. Acom                            =       0.065 m^2.
           -. DCcy                            =       0.080 m.
           -. DCcz                            =       0.080 m.
           -. Cc     = 0.85*fc*Acom           =     1542.24 kN.
           -. MnCy   = Cc*DCcz                =      123.45 kN-m.
           -. MnCz   = Cc*DCcy                =      123.31 kN-m.

      ( ). Compute capacity of reinforcement.
      ---------------------------------------------------------------------------------------------------
       i      dsi       esi         fsi         Asi         Fsi      dzi        MnPyi      dyi       MnPzi
      ---------------------------------------------------------------------------------------------------
       1    0.509 -0.002100 -420000.00  5.097e-04    -214.06   -0.160       34.25   -0.160       34.25
       2    0.283  0.000168   33505.13  5.097e-04      17.08    0.160        2.73   -0.160       -2.73
       3    0.057  0.002433  420000.00  5.097e-04     214.06    0.160       34.25    0.160       34.25
       4    0.283  0.000166   33161.53  5.097e-04      16.90   -0.160       -2.70    0.160        2.70
      ---------------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ------------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =       33.98 kN.
```

```
-. MnPy   = SUM [ MnPyi ]  =       68.53 kN-m.
-. MnPz   = SUM [ MnPzi ]  =       68.47 kN-m.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute nominal capacity(Pb,Mb) of Balanced Condition.
           -. Pb     = Cc + Ps                =      1576.22 kN.
           -. Mny    = MnCy + MnPy            =       191.98 kN-m.
           -. Mnz    = MnCz + MnPz            =       191.78 kN-m.
           -. Mb     = SQRT(Mny^2+Mnz^2)      =       271.36 kN-m.

      ( ). Compare actual eccentricity with balanced eccentricity.
           -. Balanced eccentricity : eb   = Mb/Pb        =    0.172 m.
           -. Minimum eccentricity  : Emin (not defined)  =    0.000 m.
           -. Actual eccentricity   : Eccn = Mu/Pu        =    0.696 m.
           -. eb   < Eccn       --->  Tension controls.

     ----------------------------------------------------------------------------
       *. Final analysis with searched neutral axis.
     ----------------------------------------------------------------------------

      ( ). Search for neutral axis......     Unit :  kN.,  m.
           -. P-M calculation method : Keep P constant
          -----------------------------------------------------
           Trial          c       Phi*Pn       Pu       Ratio
          -----------------------------------------------------
            1-st      0.180       181.10      96.907     53.51
            2-nd      0.173       105.59      96.907     91.78
            3-rd      0.169        67.22      96.907     55.85
            4-th      0.171        86.46      96.907     87.92
            5-th      0.172        96.04      96.907     99.09
            6-th      0.173       100.82      96.907     96.12
            7-th      0.172        98.43      96.907     98.46
            8-th      0.172        97.23      96.907     99.67
          -----------------------------------------------------

      ( ). Compute capacity of compression stress block.
           -. a      = beta1*c                =        0.146 m.
           -. Acom                            =        0.021 m^2.
           -. DCcy                            =        0.131 m.
           -. DCcz                            =        0.131 m.
           -. Cc     = 0.85*fc*Acom           =       509.82 kN.
           -. MnCy   = Cc*DCcz                =        66.80 kN-m.
           -. MnCz   = Cc*DCcy                =        66.78 kN-m.

      ( ). Compute capacity of reinforcement.
```

i	dsi	esi	fsi	Asi	Fsi	dzi	MnPyi	dyi	MnPzi
1	0.509	-0.005870	-420000.00	5.097e-04	-214.06	-0.160	34.25	-0.160	34.25
2	0.283	-0.001926	-385293.16	5.097e-04	-196.37	0.160	-31.42	-0.160	31.42
3	0.057	0.002014	402881.61	5.097e-04	205.34	0.160	32.85	0.160	32.85
4	0.283	-0.001929	-385890.78	5.097e-04	-196.68	-0.160	31.47	0.160	-31.47

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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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      ----------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      -------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =     -401.78 kN.
           -. MnPy   = SUM [ MnPyi ]  =       67.15 kN-m.
           -. MnPz   = SUM [ MnPzi ]  =       67.06 kN-m.

      ( ). Compute nominal capacity(Pn,Mn) of given neutral axis.
           -. Pn     = Cc + Ps                =      108.04 kN.
           -. Mny    = MnCy + MnPy            =      133.96 kN-m.
           -. Mnz    = MnCz + MnPz            =      133.83 kN-m.
           -. Mn     = SQRT(Mny^2+Mnz^2)      =      189.35 kN-m.

      ( ). Compute strength reduction factor.
           -. et       = 0.00587
           -. et_min  = 0.00210
           -. et_max  = 0.00500
           -. et > et_max  --->  phi =0.900

      ( ). Compute axial load and moment capacities(phiPn,phiMn).
           -. phiPn  = phi*Pn  =       97.23 kN.
           -. phiMn  = phi*Mn  =      170.42 kN-m.
           -. phiMny = phi*Mny =      120.56 kN-m.
           -. phiMnz = phi*Mnz =      120.45 kN-m.

      ( ). Check ratios of axial load and moment capacity.
           -. Rat_P  = Pu/phiPn = 0.997  <  1.000  --->  O.K.
           -. Rat_M  = Mc/phiMn = 0.396  <  1.000  --->  O.K.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   28,  POS = J )
           -. Applied axial force : Pu  =       83.09 kN.
           -. Applied shear force : Vuz =       20.59 kN.
           -. d      = Hc-do    =    0.360 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      134.34 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      100.76 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   25,  POS = J )
           -. Applied axial force : Pu  =       83.07 kN.
           -. Applied shear force : Vuy =       20.58 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      134.34 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      100.75 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   28,  POS = 1/2 )
           -. Applied axial force : Pu  =       90.00 kN.
           -. Applied shear force : Vuz =       20.59 kN.
           -. d      = Hc-do    =    0.360 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      134.74 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      101.06 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   25,  POS = 1/2 )
           -. Applied axial force : Pu  =       89.99 kN.
           -. Applied shear force : Vuy =       20.58 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      134.74 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      101.05 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      *.midas Gen - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = COLUMN ,  MEMB =     5,  LCB =   26,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     1) : C40*40
        Section Type : Rectangular with Ties (RT)
        Section Height (HTc)           =        4.000 m.
        Section Depth  (Hc)            =        0.400 m.
        Section Width  (Bc)            =        0.400 m.
        Concrete Cover to C.O.R. (do)  =        0.040 m.
        Concrete Strength (fc)         =    28000.000 KPa.
        Modulus of Elasticity (Ec)     =  24870062.324 KPa.
        Main Rebar Strength (fy)       =   420000.000 KPa.
        Ties/Spirals Strength (fys)    =   420000.000 KPa.
        Modulus of Elasticity (Es)     = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

     *.REBAR PATTERN = RT -  4 -  2 - #8          Unit :  m.
        --------------------------------------------------------
           i          dyi          dzi      Rebar          Asi
        --------------------------------------------------------
           1       -0.160       -0.160      1-#8       0.00051
           2       -0.160        0.160      1-#8       0.00051
           3        0.160        0.160      1-#8       0.00051
           4        0.160       -0.160      1-#8       0.00051
        --------------------------------------------------------

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

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =   26
           -------------------------------------------------------------------------------
            Load Case             Pu           Myi           Myj           Mzi           Mzj
           -------------------------------------------------------------------------------
            DL                125.21         -0.60          0.37         -0.66          0.50
            LL                 -0.00          0.00          0.00          0.00          0.00
            DL+LL             125.21         -0.60          0.37         -0.66          0.50
            Others             11.10         38.36         38.03         38.37         38.22
           -------------------------------------------------------------------------------
            DL+LL+Others      136.31         37.76         38.40         37.71         38.72
           -------------------------------------------------------------------------------
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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     ( ). Compute member end moments(M1,M2).  Unit : kN-m.
          -. For Dead Load(DL).
             My1D =          0.37,    My2D =          0.60
             Mz1D =          0.50,    Mz2D =          0.66
          -. For Gravity Load(DL+LL).
             My1G =          0.37,    My2G =          0.60
             Mz1G =          0.50,    Mz2G =          0.66
          -. For Total Load(DL+LL+WL(EL)).
             My1  =         37.76,    My2  =         38.40
             Mz1  =         37.71,    Mz2  =         38.72

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. Slenderness ratio limits.
             SRy(Braced)    =  34 - 12*| My1/My2 | =   22.201  (Single curvature)
             SRz(Braced)    =  34 - 12*| Mz1/Mz2 | =   22.312  (Single curvature)
          -. Radii of gyration.
             ry     =  0.30*Hc  =    0.120 m.
             rz     =  0.30*Bc  =    0.120 m.
          -. Unbraced lengths.
             Ly     =    4.000 m.
             Lz     =    4.000 m.
          -. Effective length factors.
             Ky     =    1.000
             Kz     =    1.000
          -. SLENy  =  Ky*Ly/ry  =   33.333  >  SRy  --->  SLENDER.
          -. SLENz  =  Kz*Lz/rz  =   33.333  >  SRz  --->  SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. Ec       =  4700*SQRT[fc]                   =  2.4870e+07 KPa.
          -. Ryy      =  Bc*Hc^3/12                      =        0.0021 m^4.
          -. Rse                                         =    5.2273e-05 m^4.
          -. Betadnsy =  Pu_D/Pu                         =   0.9186
          -. EIy      =  (0.2*Ec*Ryy+Es*Rse)/(1+Betadnsy) =    10979.9602 (by N, mm).
          -. Pu       =  Pu_G + Pu_S          =       136.31 kN.
          -. Single Curvature Bending.
          -. Cmy      =        0.85 (Default or User defined value)
          -. Pcy      =  (pi^2*EIy)/(Ky*Ly)^2  =     6772.99 kN.
          -. DBy      =  Cmy/(1-Pu/(0.75*Pcy)) =        0.87
          -. DBy  <  1.0  --->  DBy  =  1.00
          -. DSy    =     1.00 (Default value)

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. Ec       =  4700*SQRT[fc]                   =  2.4870e+07 KPa.
          -. Rzz      =  Hc*Bc^3/12                      =        0.0021 m^4.
          -. Rse                                         =    5.2273e-05 m^4.
          -. Betadnsz =  Pu_D/Pu                         =   0.9186
          -. EIz      =  (0.2*Ec*Rzz+Es*Rse)/(1+Betadnsz) =    10979.9602 (by N, mm).
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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           -. Pu       =  Pu_G + Pu_S           =      136.31 kN.
           -. Single Curvature Bending.
           -. Cmz      =        0.85 (Default or User defined value)
           -. Pcz      =  (pi^2*EIz)/(Kz*Lz)^2  =     6772.99 kN.
           -. DBz      =  Cmz/(1-Pu/(0.75*Pcz)) =        0.87
           -. DBz  <  1.0  --->  DBz  =  1.00
           -. DSz    =     1.00 (Default value)

      ( ). Compute minimum moments(Mmin).
           -. emin_y  =  15 mm. + 0.03*Hc   =       0.027 m.
           -. emin_z  =  15 mm. + 0.03*Bc   =       0.027 m.
           -. Mmin_y  =  Pu * emin_y        =        3.68 kN-m.
           -. Mmin_z  =  Pu * emin_z        =        3.68 kN-m.

      ( ). Compute magnified moments. (Pos : J, Local-y : Braced, Local-z : Braced).
           -. No sidesway moments.
              QMb_y  =  My_G   =        0.37 kN-m.
              QMb_z  =  Mz_G   =        0.50 kN-m.
           -. Sidesway moments.
              QMs_y  =  My_S   =       38.03 kN-m.
              QMs_z  =  Mz_S   =       38.22 kN-m.
           -. Compute magnified moments(Mcy,Mcz).
              Mcy(Slender)    =  DBy*MAX(Mmin_y, QMb_y+QMs_y)     =       38.40 kN-m.
              Mcz(Slender)    =  DBz*MAX(Mmin_z, QMb_z+QMs_z)     =       38.72 kN-m.

      ( ). Check total moment including 2nd-order effects.
           -. Moments due to 1st-order effects.
              Mcy-1st =        38.40 kN-m.
              Mcz-1st =        38.72 kN-m.
           -. Moments due to 2nd-order effects.
              Mcy-2nd = DBy*(QMb_y + QMs_y) =        38.40 kN-m.
              Mcz-2nd = DBz*(QMb_z + QMs_z) =        38.72 kN-m.
           -. Ratio of moment due to 2nd-order effects to moment due to 1st-order effects.
              Mcy-2nd / Mcy-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.
              Mcz-2nd / Mcz-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.

      ( ). Design forces/moments of column(brace).
           -. Axial Force (Compression)      Pu   =      136.31 kN.
           -. Combined Bending Moment        Mc   =       54.53 kN-m.
           -. Bending Moment about Local-y   Mcy =       38.40 kN-m.
           -. Bending Moment about Local-z   Mcz =       38.72 kN-m.
           -. Shear Force of Local-y         Vuy =       20.85 kN.
           -. Shear Force of Local-z         Vuz =       20.91 kN.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC_COLUMN(RC-BRACE).
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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute design parameters.
           -. Ag     =              0.1600 m^2.
           -. Ast    =              0.0020 m^2.
           -. Rhot   = Ast/Ag =   0.012742
           -. esu    = fy/Es  =   0.002100
           -. beta1  =   0.8500  ( fc < 28 MPa.)

      ( ). Check the ratio of reinforcement.
           -. Rhomin =   0.010000
           -. Rhomax =   0.040000
           -. Rhot   =   0.012742
              Rhomin < Rhot < Rhomax  --->  O.K !

      ( ). Compute eccentricities of biaxially loaded column.
           -. Ecny   = ABS(Mcz/Pu)     =      0.2840 m.
           -. Ecnz   = ABS(Mcy/Pu)     =      0.2817 m.
           -. Eccn   = ABS(Mc/Pu)      =      0.4001 m.
           -. Rota   = ATAN(Ecny/Ecnz) =     45.2325 deg.
           -. Rotation of neutral axis =     45.2325 deg.

      ( ). Compute concentric axial load capacity.
           -. Po     = (0.85*fc)*(Ag-Ast) + fy*Ast    =     4615.74 kN.
           -. Maximum Axial Load    : Pomax = 0.75*Po =     3461.80 kN.
           -. Maximum Axial Tension : Pt    = -fy*Ast =     -856.26 kN.

     ----------------------------------------------------------------------------
       *. Analysis of balanced condition.
     ----------------------------------------------------------------------------

      ( ). Compute capacity of concrete stress block.
           -. cb     = (0.003/(0.003+esu))*d  =       0.299 m.
           -. ab     = beta1*cb               =       0.255 m.
           -. Acom                            =       0.065 m^2.
           -. DCcy                            =       0.080 m.
           -. DCcz                            =       0.080 m.
           -. Cc     = 0.85*fc*Acom           =     1542.27 kN.
           -. MnCy   = Cc*DCcz                =      122.63 kN-m.
           -. MnCz   = Cc*DCcy                =      124.13 kN-m.

      ( ). Compute capacity of reinforcement.
      -----------------------------------------------------------------------------------------------
       i      dsi       esi         fsi         Asi         Fsi      dzi        MnPyi      dyi       MnPzi
      -----------------------------------------------------------------------------------------------
       1    0.509 -0.002100 -420000.00  5.097e-04    -214.06   -0.160       34.25   -0.160       34.25
       2    0.284  0.000157   31493.90  5.097e-04      16.05    0.160        2.57   -0.160       -2.57
       3    0.057  0.002433  420000.00  5.097e-04     214.06    0.160       34.25    0.160       34.25
       4    0.282  0.000176   35172.77  5.097e-04      17.93   -0.160       -2.87    0.160        2.87
      -----------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      -----------------------------------------------------------------------------------------------
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           -. Ps     = SUM [ Fsi ]    =       33.98 kN.
```

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-. MnPy   = SUM [ MnPyi ]  =       68.20 kN-m.
-. MnPz   = SUM [ MnPzi ]  =       68.80 kN-m.
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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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      ( ). Compute nominal capacity(Pb,Mb) of Balanced Condition.
           -. Pb     = Cc + Ps                =     1576.24 kN.
           -. Mny    = MnCy + MnPy            =      190.83 kN-m.
           -. Mnz    = MnCz + MnPz            =      192.93 kN-m.
           -. Mb     = SQRT(Mny^2+Mnz^2)      =      271.36 kN-m.

      ( ). Compare actual eccentricity with balanced eccentricity.
           -. Balanced eccentricity : eb   = Mb/Pb        =    0.172 m.
           -. Minimum eccentricity  : Emin (not defined)  =    0.000 m.
           -. Actual eccentricity   : Eccn = Mu/Pu        =    0.400 m.
           -. eb   < Eccn       --->  Tension controls.

     ----------------------------------------------------------------------------
       *. Final analysis with searched neutral axis.
     ----------------------------------------------------------------------------

      ( ). Search for neutral axis......     Unit :  kN.,  m.
           -. P-M calculation method : Keep P constant
          -----------------------------------------------------
           Trial          c       Phi*Pn       Pu       Ratio
          -----------------------------------------------------
            1-st      0.180       181.11     136.312     75.26
            2-nd      0.173       105.59     136.312     70.91
            3-rd      0.176       143.54     136.312     94.96
            4-th      0.175       124.62     136.312     90.61
            5-th      0.176       134.09     136.312     98.34
            6-th      0.176       138.82     136.312     98.20
            7-th      0.176       136.45     136.312     99.90
          -----------------------------------------------------

      ( ). Compute capacity of compression stress block.
           -. a      = beta1*c                =       0.149 m.
           -. Acom                            =       0.022 m^2.
           -. DCcy                            =       0.130 m.
           -. DCcz                            =       0.129 m.
           -. Cc     = 0.85*fc*Acom           =      531.07 kN.
           -. MnCy   = Cc*DCcz                =       68.66 kN-m.
           -. MnCz   = Cc*DCcy                =       68.97 kN-m.

      ( ). Compute capacity of reinforcement.
      ---------------------------------------------------------------------------------------------
       i      dsi       esi         fsi         Asi         Fsi      dzi        MnPyi      dyi       MnPzi
      ---------------------------------------------------------------------------------------------
       1    0.509 -0.005691 -420000.00  5.097e-04    -214.06   -0.160       34.25   -0.160       34.25
       2    0.284 -0.001844 -368813.25  5.097e-04    -187.98    0.160      -30.08   -0.160       30.08
       3    0.057  0.002034  406864.28  5.097e-04     207.37    0.160       33.18    0.160       33.18
       4    0.282 -0.001813 -362543.94  5.097e-04    -184.78   -0.160       29.56    0.160      -29.56
      ---------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ----------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =     -379.45 kN.
```

```
-. MnPy   = SUM [ MnPyi ]  =       66.92 kN-m.
-. MnPz   = SUM [ MnPzi ]  =       67.94 kN-m.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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      ( ). Compute nominal capacity(Pn,Mn) of given neutral axis.
           -. Pn     = Cc + Ps               =      151.62 kN.
           -. Mny    = MnCy + MnPy           =      135.58 kN-m.
           -. Mnz    = MnCz + MnPz           =      136.91 kN-m.
           -. Mn     = SQRT(Mny^2+Mnz^2)     =      192.68 kN-m.

      ( ). Compute strength reduction factor.
           -. et       = 0.00569
           -. et_min  = 0.00210
           -. et_max  = 0.00500
           -. et > et_max  --->  phi =0.900

      ( ). Compute axial load and moment capacities(phiPn,phiMn).
           -. phiPn  = phi*Pn  =      136.45 kN.
           -. phiMn  = phi*Mn  =      173.41 kN-m.
           -. phiMny = phi*Mny =      122.02 kN-m.
           -. phiMnz = phi*Mnz =      123.22 kN-m.

      ( ). Check ratios of axial load and moment capacity.
           -. Rat_P  = Pu/phiPn = 0.999  <  1.000  --->  O.K.
           -. Rat_M  = Mc/phiMn = 0.314  <  1.000  --->  O.K.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   28,  POS = J )
           -. Applied axial force : Pu  =      136.33 kN.
           -. Applied shear force : Vuz =       20.91 kN.
           -. d      = Hc-do    =    0.360 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      137.42 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      103.06 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   25,  POS = J )
           -. Applied axial force : Pu  =      136.31 kN.
           -. Applied shear force : Vuy =       20.85 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.400 m.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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          -. Acv    = Bw*d      =    0.144 m^2.
          -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      137.42 kN.
          -. phi    = 0.75
          -. phiVc  = phi*Vc    =      103.06 kN.
          -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.

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

      ( ). Compute maximum spacing of ties.
          -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   28,  POS = 1/2 )
          -. Applied axial force : Pu  =      143.24 kN.
          -. Applied shear force : Vuz =       20.91 kN.
          -. d      = Hc-do     =    0.360 m.
          -. Bw     = Bc        =    0.400 m.
          -. Acv    = Bw*d      =    0.144 m^2.
          -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      137.82 kN.
          -. phi    = 0.75
          -. phiVc  = phi*Vc    =      103.36 kN.
          -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   25,  POS = 1/2 )
          -. Applied axial force : Pu  =      143.23 kN.
          -. Applied shear force : Vuy =       20.85 kN.
          -. d      = Bc-do     =    0.360 m.
          -. Bw     = Hc        =    0.400 m.
          -. Acv    = Bw*d      =    0.144 m^2.
          -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      137.82 kN.
          -. phi    = 0.75
          -. phiVc  = phi*Vc    =      103.36 kN.
          -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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      *.midas Gen - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = COLUMN ,  MEMB =     6,  LCB =   17,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     1) : C40*40
        Section Type : Rectangular with Ties (RT)
        Section Height (HTc)            =        4.000 m.
        Section Depth  (Hc)             =        0.400 m.
        Section Width  (Bc)             =        0.400 m.
        Concrete Cover to C.O.R. (do)   =        0.040 m.
        Concrete Strength (fc)          =    28000.000 KPa.
        Modulus of Elasticity (Ec)      =  24870062.324 KPa.
        Main Rebar Strength (fy)        =   420000.000 KPa.
        Ties/Spirals Strength (fys)     =   420000.000 KPa.
        Modulus of Elasticity (Es)      = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

     *.REBAR PATTERN = RT -  4 -  2 - #8         Unit :  m.
        -------------------------------------------------------
           i          dyi          dzi      Rebar          Asi
        -------------------------------------------------------
           1       -0.160       -0.160      1-#8       0.00051
           2       -0.160        0.160      1-#8       0.00051
           3        0.160        0.160      1-#8       0.00051
           4        0.160       -0.160      1-#8       0.00051
        -------------------------------------------------------

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

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =   17
           ------------------------------------------------------------------------------
            Load Case              Pu           Myi           Myj           Mzi           Mzj
           ------------------------------------------------------------------------------
            DL                 139.70         -1.96          3.22         -1.71          2.94
            LL                  -0.00          0.00          0.00          0.00          0.00
            DL+LL              139.70         -1.96          3.22         -1.71          2.94
            Others              80.84         24.85         46.02         25.07         45.79
           ------------------------------------------------------------------------------
            DL+LL+Others       220.54         22.89         49.24         23.36         48.73
           ------------------------------------------------------------------------------
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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute member end moments(M1,M2).  Unit : kN-m.
           -. For Dead Load(DL).
              My1D =         1.96,   My2D =         3.22
              Mz1D =         1.71,   Mz2D =         2.94
           -. For Gravity Load(DL+LL).
              My1G =         1.96,   My2G =         3.22
              Mz1G =         1.71,   Mz2G =         2.94
           -. For Total Load(DL+LL+WL(EL)).
              My1  =        22.89,   My2  =        49.24
              Mz1  =        23.36,   Mz2  =        48.73

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. Slenderness ratio limits.
              SRy(Braced)   =  34 - 12*| My1/My2 | =   28.423  (Single curvature)
              SRz(Braced)   =  34 - 12*| Mz1/Mz2 | =   28.248  (Single curvature)
           -. Radii of gyration.
              ry     =  0.30*Hc  =    0.120 m.
              rz     =  0.30*Bc  =    0.120 m.
           -. Unbraced lengths.
              Ly     =    4.000 m.
              Lz     =    4.000 m.
           -. Effective length factors.
              Ky     =    1.000
              Kz     =    1.000
           -. SLENy  =  Ky*Ly/ry  =   33.333  >  SRy  --->  SLENDER.
           -. SLENz  =  Kz*Lz/rz  =   33.333  >  SRz  --->  SLENDER.

      ( ). Compute moment magnification factors for major axis(DBy,DSy).
           -. Ec       =  4700*SQRT[fc]                  =  2.4870e+07 KPa.
           -. Ryy      =  Bc*Hc^3/12                     =        0.0021 m^4.
           -. Rse                                        =    5.2273e-05 m^4.
           -. Betadnsy =  Pu_D/Pu                        =   0.6334
           -. EIy      =  (0.2*Ec*Ryy+Es*Rse)/(1+Betadnsy) =    12896.5453 (by N, mm).
           -. Pu       =  Pu_G + Pu_S           =       220.54 kN.
           -. Single Curvature Bending.
           -. Cmy      =        0.85 (Default or User defined value)
           -. Pcy      =  (pi^2*EIy)/(Ky*Ly)^2  =     7955.24 kN.
           -. DBy      =  Cmy/(1-Pu/(0.75*Pcy)) =        0.88
           -. DBy  <  1.0  --->  DBy  =  1.00
           -. DSy    =     1.00 (Default value)

      ( ). Compute moment magnification factors for minor axis(DBz,DSz).
           -. Ec       =  4700*SQRT[fc]                  =  2.4870e+07 KPa.
           -. Rzz      =  Hc*Bc^3/12                     =        0.0021 m^4.
           -. Rse                                        =    5.2273e-05 m^4.
           -. Betadnsz =  Pu_D/Pu                        =   0.6334
           -. EIz      =  (0.2*Ec*Rzz+Es*Rse)/(1+Betadnsz) =    12896.5453 (by N, mm).
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 midas Gen - RC-Column Design   [ NSR-10 ]                                   Gen 2022
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           -. Pu       =  Pu_G + Pu_S           =      220.54 kN.
           -. Single Curvature Bending.
           -. Cmz      =        0.85 (Default or User defined value)
           -. Pcz      =  (pi^2*EIz)/(Kz*Lz)^2  =     7955.24 kN.
           -. DBz      =  Cmz/(1-Pu/(0.75*Pcz)) =        0.88
           -. DBz  <  1.0  --->  DBz  =  1.00
           -. DSz    =     1.00 (Default value)

      ( ). Compute minimum moments(Mmin).
           -. emin_y  =  15 mm. + 0.03*Hc    =       0.027 m.
           -. emin_z  =  15 mm. + 0.03*Bc    =       0.027 m.
           -. Mmin_y  =  Pu * emin_y         =        5.95 kN-m.
           -. Mmin_z  =  Pu * emin_z         =        5.95 kN-m.

      ( ). Compute magnified moments. (Pos : J, Local-y : Braced, Local-z : Braced).
           -. No sidesway moments.
              QMb_y  =  My_G   =        3.22 kN-m.
              QMb_z  =  Mz_G   =        2.94 kN-m.
           -. Sidesway moments.
              QMs_y  =  My_S   =       46.02 kN-m.
              QMs_z  =  Mz_S   =       45.79 kN-m.
           -. Compute magnified moments(Mcy,Mcz).
              Mcy(Slender)    =  DBy*MAX(Mmin_y, QMb_y+QMs_y)     =       49.24 kN-m.
              Mcz(Slender)    =  DBz*MAX(Mmin_z, QMb_z+QMs_z)     =       48.73 kN-m.

      ( ). Check total moment including 2nd-order effects.
           -. Moments due to 1st-order effects.
              Mcy-1st =        49.24 kN-m.
              Mcz-1st =        48.73 kN-m.
           -. Moments due to 2nd-order effects.
              Mcy-2nd = DBy*(QMb_y + QMs_y) =        49.24 kN-m.
              Mcz-2nd = DBz*(QMb_z + QMs_z) =        48.73 kN-m.
           -. Ratio of moment due to 2nd-order effects to moment due to 1st-order effects.
              Mcy-2nd / Mcy-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.
              Mcz-2nd / Mcz-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.

      ( ). Design forces/moments of column(brace).
           -. Axial Force (Compression)      Pu   =      220.54 kN.
           -. Combined Bending Moment        Mc   =       69.28 kN-m.
           -. Bending Moment about Local-y   Mcy =       49.24 kN-m.
           -. Bending Moment about Local-z   Mcz =       48.73 kN-m.
           -. Shear Force of Local-y         Vuy =       21.46 kN.
           -. Shear Force of Local-z         Vuz =       21.71 kN.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC_COLUMN(RC-BRACE).
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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute design parameters.
           -. Ag     =              0.1600 m^2.
           -. Ast    =              0.0020 m^2.
           -. Rhot   = Ast/Ag =   0.012742
           -. esu    = fy/Es  =   0.002100
           -. beta1  =   0.8500  ( fc < 28 MPa.)

      ( ). Check the ratio of reinforcement.
           -. Rhomin =   0.010000
           -. Rhomax =   0.040000
           -. Rhot   =   0.012742
              Rhomin < Rhot < Rhomax  --->  O.K !

      ( ). Compute eccentricities of biaxially loaded column.
           -. Ecny   = ABS(Mcz/Pu)     =      0.2210 m.
           -. Ecnz   = ABS(Mcy/Pu)     =      0.2233 m.
           -. Eccn   = ABS(Mc/Pu)      =      0.3141 m.
           -. Rota   = ATAN(Ecny/Ecnz) =     44.6998 deg.
           -. Rotation of neutral axis =     44.6998 deg.

      ( ). Compute concentric axial load capacity.
           -. Po     = (0.85*fc)*(Ag-Ast) + fy*Ast    =     4615.74 kN.
           -. Maximum Axial Load    : Pomax = 0.75*Po =     3461.80 kN.
           -. Maximum Axial Tension : Pt    = -fy*Ast =     -856.26 kN.

     ----------------------------------------------------------------------------
       *. Analysis of balanced condition.
     ----------------------------------------------------------------------------

      ( ). Compute capacity of concrete stress block.
           -. cb     = (0.003/(0.003+esu))*d  =       0.299 m.
           -. ab     = beta1*cb               =       0.255 m.
           -. Acom                            =       0.065 m^2.
           -. DCcy                            =       0.079 m.
           -. DCcz                            =       0.081 m.
           -. Cc     = 0.85*fc*Acom           =     1542.28 kN.
           -. MnCy   = Cc*DCcz                =      124.35 kN-m.
           -. MnCz   = Cc*DCcy                =      122.41 kN-m.

      ( ). Compute capacity of reinforcement.
      ------------------------------------------------------------------------------------------------
       i      dsi       esi         fsi         Asi         Fsi      dzi        MnPyi      dyi       MnPzi
      ------------------------------------------------------------------------------------------------
       1    0.509 -0.002100 -420000.00  5.097e-04    -214.06   -0.160       34.25   -0.160       34.25
       2    0.282  0.000179   35708.22  5.097e-04      18.20    0.160        2.91   -0.160       -2.91
       3    0.057  0.002433  420000.00  5.097e-04     214.06    0.160       34.25    0.160       34.25
       4    0.284  0.000155   30958.45  5.097e-04      15.78   -0.160       -2.52    0.160        2.52
      ------------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ----------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =       33.98 kN.
```

```
-. MnPy   = SUM [ MnPyi ]  =       68.89 kN-m.
-. MnPz   = SUM [ MnPzi ]  =       68.11 kN-m.
```

```
----------------------------------------------------------------------------------------
 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
========================================================================================


      ( ). Compute nominal capacity(Pb,Mb) of Balanced Condition.
           -. Pb     = Cc + Ps                =     1576.26 kN.
           -. Mny    = MnCy + MnPy            =      193.23 kN-m.
           -. Mnz    = MnCz + MnPz            =      190.52 kN-m.
           -. Mb     = SQRT(Mny^2+Mnz^2)      =      271.36 kN-m.

      ( ). Compare actual eccentricity with balanced eccentricity.
           -. Balanced eccentricity : eb   = Mb/Pb         =    0.172 m.
           -. Minimum eccentricity  : Emin (not defined)  =    0.000 m.
           -. Actual eccentricity   : Eccn = Mu/Pu         =    0.314 m.
           -. eb   < Eccn       --->  Tension controls.

     ---------------------------------------------------------------------------
       *. Final analysis with searched neutral axis.
     ---------------------------------------------------------------------------

      ( ). Search for neutral axis......     Unit :  kN.,  m.
           -. P-M calculation method : Keep P constant
          ----------------------------------------------------
           Trial          c       Phi*Pn       Pu       Ratio
          ----------------------------------------------------
            1-st      0.180       181.12     220.538     78.23
            2-nd      0.187       255.30     220.538     86.38
            3-rd      0.183       218.36     220.538     99.00
            4-th      0.185       236.86     220.538     93.11
            5-th      0.184       227.62     220.538     96.89
            6-th      0.184       222.99     220.538     98.90
            7-th      0.183       220.67     220.538     99.94
          ----------------------------------------------------

      ( ). Compute capacity of compression stress block.
           -. a      = beta1*c                =       0.156 m.
           -. Acom                            =       0.024 m^2.
           -. DCcy                            =       0.126 m.
           -. DCcz                            =       0.127 m.
           -. Cc     = 0.85*fc*Acom           =      578.93 kN.
           -. MnCy   = Cc*DCcz                =       73.44 kN-m.
           -. MnCz   = Cc*DCcy                =       73.00 kN-m.

      ( ). Compute capacity of reinforcement.
      ----------------------------------------------------------------------------------------------
       i      dsi       esi        fsi        Asi         Fsi      dzi        MnPyi      dyi       MnPzi
      ----------------------------------------------------------------------------------------------
       1    0.509 -0.005324 -420000.00  5.097e-04    -214.06   -0.160       34.25   -0.160       34.25
       2    0.282 -0.001605 -321030.13  5.097e-04    -163.62    0.160      -26.18   -0.160       26.18
       3    0.057  0.002075  415018.72  5.097e-04     211.53    0.160       33.84    0.160       33.84
       4    0.284 -0.001644 -328782.66  5.097e-04    -167.57   -0.160       26.81    0.160      -26.81
      ----------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      -----------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =     -333.73 kN.
```

```
-. MnPy   = SUM [ MnPyi ]  =       68.73 kN-m.
-. MnPz   = SUM [ MnPzi ]  =       67.46 kN-m.
```

```
---------------------------------------------------------------------------------------
 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute nominal capacity(Pn,Mn) of given neutral axis.
           -. Pn     = Cc + Ps                =      245.19 kN.
           -. Mny    = MnCy + MnPy            =      142.17 kN-m.
           -. Mnz    = MnCz + MnPz            =      140.46 kN-m.
           -. Mn     = SQRT(Mny^2+Mnz^2)      =      199.85 kN-m.

      ( ). Compute strength reduction factor.
           -. et      = 0.00532
           -. et_min  = 0.00210
           -. et_max  = 0.00500
           -. et > et_max  --->  phi =0.900

      ( ). Compute axial load and moment capacities(phiPn,phiMn).
           -. phiPn  = phi*Pn  =      220.67 kN.
           -. phiMn  = phi*Mn  =      179.87 kN-m.
           -. phiMny = phi*Mny =      127.95 kN-m.
           -. phiMnz = phi*Mnz =      126.41 kN-m.

      ( ). Check ratios of axial load and moment capacity.
           -. Rat_P  = Pu/phiPn = 0.999  <  1.000  --->  O.K.
           -. Rat_M  = Mc/phiMn = 0.385  <  1.000  --->  O.K.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   19,  POS = J )
           -. Applied axial force : Pu  =      240.40 kN.
           -. Applied shear force : Vuz =       21.71 kN.
           -. d      = Hc-do    =    0.360 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      143.44 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      107.58 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   22,  POS = J )
           -. Applied axial force : Pu  =      240.39 kN.
           -. Applied shear force : Vuy =       21.46 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.400 m.
```

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-----------------------------------------------------------------------------------------
 midas Gen - RC-Column Design   [ NSR-10 ]                                     Gen 2022
=========================================================================================

           -. Acv    = Bw*d      =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      143.44 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc    =      107.58 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   19,  POS = 1/2 )
           -. Applied axial force : Pu  =      249.62 kN.
           -. Applied shear force : Vuz =       21.71 kN.
           -. d      = Hc-do     =    0.360 m.
           -. Bw     = Bc        =    0.400 m.
           -. Acv    = Bw*d      =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      143.97 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc    =      107.98 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   22,  POS = 1/2 )
           -. Applied axial force : Pu  =      249.61 kN.
           -. Applied shear force : Vuy =       21.46 kN.
           -. d      = Bc-do     =    0.360 m.
           -. Bw     = Hc        =    0.400 m.
           -. Acv    = Bw*d      =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      143.97 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc    =      107.98 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.
```

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--------------------------------------------------------------------------------------
 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      *.midas Gen - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = COLUMN ,  MEMB =     7,  LCB =   28,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     1) : C40*40
        Section Type : Rectangular with Ties (RT)
        Section Height (HTc)             =        4.000 m.
        Section Depth  (Hc)              =        0.400 m.
        Section Width  (Bc)              =        0.400 m.
        Concrete Cover to C.O.R. (do)    =        0.040 m.
        Concrete Strength (fc)           =    28000.000 KPa.
        Modulus of Elasticity (Ec)       =  24870062.324 KPa.
        Main Rebar Strength (fy)         =   420000.000 KPa.
        Ties/Spirals Strength (fys)      =   420000.000 KPa.
        Modulus of Elasticity (Es)       = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

     *.REBAR PATTERN = RT -  4 -  2 - #8          Unit :  m.
        --------------------------------------------------------
           i          dyi          dzi      Rebar          Asi
        --------------------------------------------------------
           1       -0.160       -0.160      1-#8       0.00051
           2       -0.160        0.160      1-#8       0.00051
           3        0.160        0.160      1-#8       0.00051
           4        0.160       -0.160      1-#8       0.00051
        --------------------------------------------------------

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

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =   28
           -------------------------------------------------------------------------------
            Load Case              Pu           Myi           Myj           Mzi           Mzj
           -------------------------------------------------------------------------------
            DL                 158.25          0.35         -0.61         -0.32          0.61
            LL                  -0.00          0.00          0.00          0.00          0.00
            DL+LL              158.25          0.35         -0.61         -0.32          0.61
            Others             -61.81         48.22         27.47         48.12         27.72
           -------------------------------------------------------------------------------
            DL+LL+Others        96.45         48.57         26.86         47.80         28.33
           -------------------------------------------------------------------------------
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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      ( ). Compute member end moments(M1,M2).  Unit : kN-m.
           -. For Dead Load(DL).
              My1D =         0.35,   My2D =         0.61
              Mz1D =         0.32,   Mz2D =         0.61
           -. For Gravity Load(DL+LL).
              My1G =         0.35,   My2G =         0.61
              Mz1G =         0.32,   Mz2G =         0.61
           -. For Total Load(DL+LL+WL(EL)).
              My1  =        26.86,   My2  =        48.57
              Mz1  =        28.33,   Mz2  =        47.80

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. Slenderness ratio limits.
              SRy(Braced)   =  34 - 12*| My1/My2 | =   27.364  (Single curvature)
              SRz(Braced)   =  34 - 12*| Mz1/Mz2 | =   26.887  (Single curvature)
           -. Radii of gyration.
              ry     =  0.30*Hc  =    0.120 m.
              rz     =  0.30*Bc  =    0.120 m.
           -. Unbraced lengths.
              Ly     =    4.000 m.
              Lz     =    4.000 m.
           -. Effective length factors.
              Ky     =    1.000
              Kz     =    1.000
           -. SLENy  =  Ky*Ly/ry  =   33.333  >  SRy  --->  SLENDER.
           -. SLENz  =  Kz*Lz/rz  =   33.333  >  SRz  --->  SLENDER.

      ( ). Compute moment magnification factors for major axis(DBy,DSy).
           -. Ec       =  4700*SQRT[fc]                    =  2.4870e+07 KPa.
           -. Ryy      =  Bc*Hc^3/12                       =        0.0021 m^4.
           -. Rse                                          =    5.2273e-05 m^4.
           -. Betadnsy =  Pu_D/Pu                          =   1.0000
           -. EIy      =  (0.2*Ec*Ryy+Es*Rse)/(1+Betadnsy) =    10532.8723 (by N, mm).
           -. Pu       =  Pu_G + Pu_S           =        96.45 kN.
           -. Single Curvature Bending.
           -. Cmy      =        0.85 (Default or User defined value)
           -. Pcy      =  (pi^2*EIy)/(Ky*Ly)^2  =     6497.21 kN.
           -. DBy      =  Cmy/(1-Pu/(0.75*Pcy)) =        0.87
           -. DBy  <  1.0  --->  DBy  =  1.00
           -. DSy    =     1.00 (Default value)

      ( ). Compute moment magnification factors for minor axis(DBz,DSz).
           -. Ec       =  4700*SQRT[fc]                    =  2.4870e+07 KPa.
           -. Rzz      =  Hc*Bc^3/12                       =        0.0021 m^4.
           -. Rse                                          =    5.2273e-05 m^4.
           -. Betadnsz =  Pu_D/Pu                          =   1.0000
           -. EIz      =  (0.2*Ec*Rzz+Es*Rse)/(1+Betadnsz) =    10532.8723 (by N, mm).
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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           -. Pu       =  Pu_G + Pu_S           =       96.45 kN.
           -. Single Curvature Bending.
           -. Cmz      =        0.85 (Default or User defined value)
           -. Pcz      =  (pi^2*EIz)/(Kz*Lz)^2  =     6497.21 kN.
           -. DBz      =  Cmz/(1-Pu/(0.75*Pcz)) =        0.87
           -. DBz  <  1.0  --->  DBz  =  1.00
           -. DSz    =     1.00 (Default value)

      ( ). Compute minimum moments(Mmin).
           -. emin_y  =  15 mm. + 0.03*Hc    =       0.027 m.
           -. emin_z  =  15 mm. + 0.03*Bc    =       0.027 m.
           -. Mmin_y  =  Pu * emin_y         =        2.60 kN-m.
           -. Mmin_z  =  Pu * emin_z         =        2.60 kN-m.

      ( ). Compute magnified moments. (Pos : I, Local-y : Braced, Local-z : Braced).
           -. No sidesway moments.
              QMb_y  =  My_G   =        0.35 kN-m.
              QMb_z  =  Mz_G   =       -0.32 kN-m.
           -. Sidesway moments.
              QMs_y  =  My_S   =       48.22 kN-m.
              QMs_z  =  Mz_S   =       48.12 kN-m.
           -. Compute magnified moments(Mcy,Mcz).
              Mcy(Slender)    =  DBy*MAX(Mmin_y, QMb_y+QMs_y)     =       48.57 kN-m.
              Mcz(Slender)    =  DBz*MAX(Mmin_z, QMb_z+QMs_z)     =       47.80 kN-m.

      ( ). Check total moment including 2nd-order effects.
           -. Moments due to 1st-order effects.
              Mcy-1st =        48.57 kN-m.
              Mcz-1st =        47.80 kN-m.
           -. Moments due to 2nd-order effects.
              Mcy-2nd = DBy*(QMb_y + QMs_y) =        48.57 kN-m.
              Mcz-2nd = DBz*(QMb_z + QMs_z) =        47.80 kN-m.
           -. Ratio of moment due to 2nd-order effects to moment due to 1st-order effects.
              Mcy-2nd / Mcy-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.
              Mcz-2nd / Mcz-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.

      ( ). Design forces/moments of column(brace).
           -. Axial Force (Compression)      Pu   =       96.45 kN.
           -. Combined Bending Moment        Mc   =       68.15 kN-m.
           -. Bending Moment about Local-y   Mcy =       48.57 kN-m.
           -. Bending Moment about Local-z   Mcz =       47.80 kN-m.
           -. Shear Force of Local-y         Vuy =       20.61 kN.
           -. Shear Force of Local-z         Vuz =       21.23 kN.

 ===============================================================================
   [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC_COLUMN(RC-BRACE).
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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute design parameters.
           -. Ag     =              0.1600 m^2.
           -. Ast    =              0.0020 m^2.
           -. Rhot   = Ast/Ag =   0.012742
           -. esu    = fy/Es  =   0.002100
           -. beta1  =   0.8500  ( fc < 28 MPa.)

      ( ). Check the ratio of reinforcement.
           -. Rhomin =   0.010000
           -. Rhomax =   0.040000
           -. Rhot   =   0.012742
              Rhomin < Rhot < Rhomax  --->  O.K !

      ( ). Compute eccentricities of biaxially loaded column.
           -. Ecny   = ABS(Mcz/Pu)     =      0.4956 m.
           -. Ecnz   = ABS(Mcy/Pu)     =      0.5036 m.
           -. Eccn   = ABS(Mc/Pu)      =      0.7066 m.
           -. Rota   = ATAN(Ecny/Ecnz) =     44.5377 deg.
           -. Rotation of neutral axis =     44.5377 deg.

      ( ). Compute concentric axial load capacity.
           -. Po     = (0.85*fc)*(Ag-Ast) + fy*Ast    =     4615.74 kN.
           -. Maximum Axial Load    : Pomax = 0.75*Po =     3461.80 kN.
           -. Maximum Axial Tension : Pt    = -fy*Ast =     -856.26 kN.

     ----------------------------------------------------------------------------
       *. Analysis of balanced condition.
     ----------------------------------------------------------------------------

      ( ). Compute capacity of concrete stress block.
           -. cb     = (0.003/(0.003+esu))*d  =       0.299 m.
           -. ab     = beta1*cb               =       0.255 m.
           -. Acom                            =       0.065 m^2.
           -. DCcy                            =       0.079 m.
           -. DCcz                            =       0.081 m.
           -. Cc     = 0.85*fc*Acom           =     1542.34 kN.
           -. MnCy   = Cc*DCcz                =      124.87 kN-m.
           -. MnCz   = Cc*DCcy                =      121.88 kN-m.

      ( ). Compute capacity of reinforcement.
      ------------------------------------------------------------------------------------------------
       i      dsi       esi         fsi        Asi         Fsi      dzi       MnPyi      dyi       MnPzi
      ------------------------------------------------------------------------------------------------
       1    0.509 -0.002100 -420000.00  5.097e-04    -214.06   -0.160       34.25   -0.160       34.25
       2    0.281  0.000185   36990.97  5.097e-04      18.85    0.160        3.02   -0.160       -3.02
       3    0.057  0.002433  420000.00  5.097e-04     214.06    0.160       34.25    0.160       34.25
       4    0.285  0.000148   29675.69  5.097e-04      15.13   -0.160       -2.42    0.160        2.42
      ------------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ----------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =       33.98 kN.
```

```
-. MnPy   = SUM [ MnPyi ]  =       69.10 kN-m.
-. MnPz   = SUM [ MnPzi ]  =       67.90 kN-m.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute nominal capacity(Pb,Mb) of Balanced Condition.
           -. Pb      = Cc + Ps                =      1576.32 kN.
           -. Mny     = MnCy + MnPy            =       193.97 kN-m.
           -. Mnz     = MnCz + MnPz            =       189.79 kN-m.
           -. Mb      = SQRT(Mny^2+Mnz^2)      =       271.37 kN-m.

      ( ). Compare actual eccentricity with balanced eccentricity.
           -. Balanced eccentricity : eb   = Mb/Pb        =    0.172 m.
           -. Minimum eccentricity  : Emin (not defined)  =    0.000 m.
           -. Actual eccentricity   : Eccn = Mu/Pu        =    0.707 m.
           -. eb   < Eccn       --->  Tension controls.

     ----------------------------------------------------------------------------
       *. Final analysis with searched neutral axis.
     ----------------------------------------------------------------------------

      ( ). Search for neutral axis......     Unit :  kN.,  m.
           -. P-M calculation method : Keep P constant
          -----------------------------------------------------
           Trial          c       Phi*Pn       Pu       Ratio
          -----------------------------------------------------
            1-st      0.180       181.14      96.447     53.25
            2-nd      0.173       105.62      96.447     91.32
            3-rd      0.169        67.25      96.447     56.59
            4-th      0.171        86.49      96.447     88.49
            5-th      0.172        96.07      96.447     99.60
            6-th      0.173       100.85      96.447     95.64
            7-th      0.172        98.46      96.447     97.96
            8-th      0.172        97.26      96.447     99.16
            9-th      0.172        96.67      96.447     99.77
          -----------------------------------------------------

      ( ). Compute capacity of compression stress block.
           -. a       = beta1*c                =        0.146 m.
           -. Acom                             =        0.021 m^2.
           -. DCcy                             =        0.130 m.
           -. DCcz                             =        0.132 m.
           -. Cc      = 0.85*fc*Acom           =       509.53 kN.
           -. MnCy    = Cc*DCcz                =        67.04 kN-m.
           -. MnCz    = Cc*DCcy                =        66.48 kN-m.

      ( ). Compute capacity of reinforcement.
      -------------------------------------------------------------------------------------------------
       i      dsi       esi        fsi         Asi          Fsi      dzi       MnPyi       dyi       MnPzi
      -------------------------------------------------------------------------------------------------
       1    0.509 -0.005873 -420000.00  5.097e-04    -214.06   -0.160       34.25    -0.160       34.25
       2    0.281 -0.001898 -379536.36  5.097e-04    -193.44    0.160      -30.95    -0.160       30.95
       3    0.057  0.002014  402820.00  5.097e-04     205.31    0.160       32.85     0.160       32.85
       4    0.285 -0.001961 -392263.65  5.097e-04    -199.93   -0.160       31.99     0.160      -31.99
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ----------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ----------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =     -402.12 kN.
           -. MnPy   = SUM [ MnPyi ]  =       68.14 kN-m.
           -. MnPz   = SUM [ MnPzi ]  =       66.06 kN-m.

      ( ). Compute nominal capacity(Pn,Mn) of given neutral axis.
           -. Pn     = Cc + Ps               =      107.41 kN.
           -. Mny    = MnCy + MnPy           =      135.18 kN-m.
           -. Mnz    = MnCz + MnPz           =      132.54 kN-m.
           -. Mn     = SQRT(Mny^2+Mnz^2)     =      189.32 kN-m.

      ( ). Compute strength reduction factor.
           -. et       = 0.00587
           -. et_min  = 0.00210
           -. et_max  = 0.00500
           -. et > et_max  --->  phi =0.900

      ( ). Compute axial load and moment capacities(phiPn,phiMn).
           -. phiPn  = phi*Pn  =       96.67 kN.
           -. phiMn  = phi*Mn  =      170.38 kN-m.
           -. phiMny = phi*Mny =      121.66 kN-m.
           -. phiMnz = phi*Mnz =      119.28 kN-m.

      ( ). Check ratios of axial load and moment capacity.
           -. Rat_P  = Pu/phiPn = 0.998  <  1.000  --->  O.K.
           -. Rat_M  = Mc/phiMn = 0.400  <  1.000  --->  O.K.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   28,  POS = J )
           -. Applied axial force : Pu  =       82.62 kN.
           -. Applied shear force : Vuz =       21.23 kN.
           -. d      = Hc-do    =    0.360 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      134.31 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      100.74 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                        Gen 2022
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      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   28,  POS = J )
           -. Applied axial force : Pu  =       82.62 kN.
           -. Applied shear force : Vuy =       20.61 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      134.31 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      100.74 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   28,  POS = 1/2 )
           -. Applied axial force : Pu  =       89.54 kN.
           -. Applied shear force : Vuz =       21.23 kN.
           -. d      = Hc-do    =    0.360 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      134.71 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      101.04 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   28,  POS = 1/2 )
           -. Applied axial force : Pu  =       89.54 kN.
           -. Applied shear force : Vuy =       20.61 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      134.71 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      101.04 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      *.midas Gen - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = COLUMN ,  MEMB =     8,  LCB =   25,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     1) : C40*40
        Section Type : Rectangular with Ties (RT)
        Section Height (HTc)            =        4.000 m.
        Section Depth  (Hc)             =        0.400 m.
        Section Width  (Bc)             =        0.400 m.
        Concrete Cover to C.O.R. (do)   =        0.040 m.
        Concrete Strength (fc)          =    28000.000 KPa.
        Modulus of Elasticity (Ec)      =  24870062.324 KPa.
        Main Rebar Strength (fy)        =   420000.000 KPa.
        Ties/Spirals Strength (fys)     =   420000.000 KPa.
        Modulus of Elasticity (Es)      = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

     *.REBAR PATTERN = RT -  4 -  2 - #8          Unit :  m.
        --------------------------------------------------------
           i          dyi          dzi      Rebar          Asi
        --------------------------------------------------------
           1       -0.160       -0.160      1-#8       0.00051
           2       -0.160        0.160      1-#8       0.00051
           3        0.160        0.160      1-#8       0.00051
           4        0.160       -0.160      1-#8       0.00051
        --------------------------------------------------------

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

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =   25
           -------------------------------------------------------------------------------
            Load Case             Pu          Myi          Myj          Mzi          Mzj
           -------------------------------------------------------------------------------
            DL                124.70         0.66        -0.50        -0.63         0.45
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL             124.70         0.66        -0.50        -0.63         0.45
            Others             11.20        38.29        38.73        38.42        38.24
           -------------------------------------------------------------------------------
            DL+LL+Others      135.89        38.95        38.24        37.79        38.69
           -------------------------------------------------------------------------------
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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      ( ). Compute member end moments(M1,M2).  Unit : kN-m.
           -. For Dead Load(DL).
              My1D =         0.50,   My2D =         0.66
              Mz1D =         0.45,   Mz2D =         0.63
           -. For Gravity Load(DL+LL).
              My1G =         0.50,   My2G =         0.66
              Mz1G =         0.45,   Mz2G =         0.63
           -. For Total Load(DL+LL+WL(EL)).
              My1  =        38.24,   My2  =        38.95
              Mz1  =        37.79,   Mz2  =        38.69

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. Slenderness ratio limits.
              SRy(Braced)   =  34 - 12*| My1/My2 | =   22.219  (Single curvature)
              SRz(Braced)   =  34 - 12*| Mz1/Mz2 | =   22.279  (Single curvature)
           -. Radii of gyration.
              ry     =  0.30*Hc  =    0.120 m.
              rz     =  0.30*Bc  =    0.120 m.
           -. Unbraced lengths.
              Ly     =    4.000 m.
              Lz     =    4.000 m.
           -. Effective length factors.
              Ky     =    1.000
              Kz     =    1.000
           -. SLENy  =  Ky*Ly/ry  =   33.333  >  SRy  --->  SLENDER.
           -. SLENz  =  Kz*Lz/rz  =   33.333  >  SRz  --->  SLENDER.

      ( ). Compute moment magnification factors for major axis(DBy,DSy).
           -. Ec       =  4700*SQRT[fc]                  =  2.4870e+07 KPa.
           -. Ryy      =  Bc*Hc^3/12                     =        0.0021 m^4.
           -. Rse                                        =    5.2273e-05 m^4.
           -. Betadnsy =  Pu_D/Pu                        =   0.9176
           -. EIy      =  (0.2*Ec*Ryy+Es*Rse)/(1+Betadnsy) =    10985.3785 (by N, mm).
           -. Pu       =  Pu_G + Pu_S          =       135.89 kN.
           -. Single Curvature Bending.
           -. Cmy      =        0.85 (Default or User defined value)
           -. Pcy      =  (pi^2*EIy)/(Ky*Ly)^2  =     6776.33 kN.
           -. DBy      =  Cmy/(1-Pu/(0.75*Pcy)) =        0.87
           -. DBy  <  1.0  --->  DBy  =  1.00
           -. DSy    =     1.00 (Default value)

      ( ). Compute moment magnification factors for minor axis(DBz,DSz).
           -. Ec       =  4700*SQRT[fc]                  =  2.4870e+07 KPa.
           -. Rzz      =  Hc*Bc^3/12                     =        0.0021 m^4.
           -. Rse                                        =    5.2273e-05 m^4.
           -. Betadnsz =  Pu_D/Pu                        =   0.9176
           -. EIz      =  (0.2*Ec*Rzz+Es*Rse)/(1+Betadnsz) =    10985.3785 (by N, mm).
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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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           -. Pu       =  Pu_G + Pu_S          =      135.89 kN.
           -. Single Curvature Bending.
           -. Cmz      =        0.85 (Default or User defined value)
           -. Pcz      =  (pi^2*EIz)/(Kz*Lz)^2  =     6776.33 kN.
           -. DBz      =  Cmz/(1-Pu/(0.75*Pcz)) =        0.87
           -. DBz  <  1.0  --->  DBz  =  1.00
           -. DSz    =     1.00 (Default value)

      ( ). Compute minimum moments(Mmin).
           -. emin_y  =  15 mm. + 0.03*Hc    =       0.027 m.
           -. emin_z  =  15 mm. + 0.03*Bc    =       0.027 m.
           -. Mmin_y  =  Pu * emin_y         =        3.67 kN-m.
           -. Mmin_z  =  Pu * emin_z         =        3.67 kN-m.

      ( ). Compute magnified moments. (Pos : J, Local-y : Braced, Local-z : Braced).
           -. No sidesway moments.
              QMb_y  =  My_G   =       -0.50 kN-m.
              QMb_z  =  Mz_G   =        0.45 kN-m.
           -. Sidesway moments.
              QMs_y  =  My_S   =       38.73 kN-m.
              QMs_z  =  Mz_S   =       38.24 kN-m.
           -. Compute magnified moments(Mcy,Mcz).
              Mcy(Slender)    =  DBy*MAX(Mmin_y, QMb_y+QMs_y)     =       38.24 kN-m.
              Mcz(Slender)    =  DBz*MAX(Mmin_z, QMb_z+QMs_z)     =       38.69 kN-m.

      ( ). Check total moment including 2nd-order effects.
           -. Moments due to 1st-order effects.
              Mcy-1st =        38.24 kN-m.
              Mcz-1st =        38.69 kN-m.
           -. Moments due to 2nd-order effects.
              Mcy-2nd = DBy*(QMb_y + QMs_y) =        38.24 kN-m.
              Mcz-2nd = DBz*(QMb_z + QMs_z) =        38.69 kN-m.
           -. Ratio of moment due to 2nd-order effects to moment due to 1st-order effects.
              Mcy-2nd / Mcy-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.
              Mcz-2nd / Mcz-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.

      ( ). Design forces/moments of column(brace).
           -. Axial Force (Compression)      Pu   =      135.89 kN.
           -. Combined Bending Moment        Mc   =       54.40 kN-m.
           -. Bending Moment about Local-y   Mcy =       38.24 kN-m.
           -. Bending Moment about Local-z   Mcz =       38.69 kN-m.
           -. Shear Force of Local-y         Vuy =       20.92 kN.
           -. Shear Force of Local-z         Vuz =       21.33 kN.

 ===============================================================================
   [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC_COLUMN(RC-BRACE).
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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute design parameters.
           -. Ag      =              0.1600 m^2.
           -. Ast     =              0.0020 m^2.
           -. Rhot    = Ast/Ag =   0.012742
           -. esu     = fy/Es  =   0.002100
           -. beta1   =   0.8500  ( fc < 28 MPa.)

      ( ). Check the ratio of reinforcement.
           -. Rhomin =   0.010000
           -. Rhomax =   0.040000
           -. Rhot   =   0.012742
              Rhomin < Rhot < Rhomax  --->  O.K !

      ( ). Compute eccentricities of biaxially loaded column.
           -. Ecny    = ABS(Mcz/Pu)      =      0.2847 m.
           -. Ecnz    = ABS(Mcy/Pu)      =      0.2814 m.
           -. Eccn    = ABS(Mc/Pu)       =      0.4003 m.
           -. Rota    = ATAN(Ecny/Ecnz) =     45.3374 deg.
           -. Rotation of neutral axis =     45.3374 deg.

      ( ). Compute concentric axial load capacity.
           -. Po      = (0.85*fc)*(Ag-Ast) + fy*Ast    =     4615.74 kN.
           -. Maximum Axial Load    : Pomax = 0.75*Po =     3461.80 kN.
           -. Maximum Axial Tension : Pt    = -fy*Ast =     -856.26 kN.

     ----------------------------------------------------------------------------
       *. Analysis of balanced condition.
     ----------------------------------------------------------------------------

      ( ). Compute capacity of concrete stress block.
           -. cb      = (0.003/(0.003+esu))*d  =       0.299 m.
           -. ab      = beta1*cb               =       0.255 m.
           -. Acom                             =       0.065 m^2.
           -. DCcy                             =       0.081 m.
           -. DCcz                             =       0.079 m.
           -. Cc      = 0.85*fc*Acom           =     1542.29 kN.
           -. MnCy    = Cc*DCcz                =      122.29 kN-m.
           -. MnCz    = Cc*DCcy                =      124.47 kN-m.

      ( ). Compute capacity of reinforcement.
```

i	dsi	esi	fsi	Asi	Fsi	dzi	MnPyi	dyi	MnPzi
1	0.509	-0.002100	-420000.00	5.097e-04	-214.06	-0.160	34.25	-0.160	34.25
2	0.284	0.000153	30663.35	5.097e-04	15.63	0.160	2.50	-0.160	-2.50
3	0.057	0.002433	420000.00	5.097e-04	214.06	0.160	34.25	0.160	34.25
4	0.282	0.000180	36003.32	5.097e-04	18.35	-0.160	-2.94	0.160	2.94

```
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      --------------------------------------------------------------------------------------------------
-----------
           -. Ps      = SUM [ Fsi ]     =       33.98 kN.
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-. MnPy   = SUM [ MnPyi ]  =       68.07 kN-m.
-. MnPz   = SUM [ MnPzi ]  =       68.94 kN-m.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute nominal capacity(Pb,Mb) of Balanced Condition.
           -. Pb     = Cc + Ps                =     1576.27 kN.
           -. Mny    = MnCy + MnPy            =      190.35 kN-m.
           -. Mnz    = MnCz + MnPz            =      193.40 kN-m.
           -. Mb     = SQRT(Mny^2+Mnz^2)      =      271.36 kN-m.

      ( ). Compare actual eccentricity with balanced eccentricity.
           -. Balanced eccentricity : eb   = Mb/Pb        =    0.172 m.
           -. Minimum eccentricity  : Emin (not defined)  =    0.000 m.
           -. Actual eccentricity   : Eccn = Mu/Pu        =    0.400 m.
           -. eb   < Eccn       --->  Tension controls.

     ----------------------------------------------------------------------------
       *. Final analysis with searched neutral axis.
     ----------------------------------------------------------------------------

      ( ). Search for neutral axis......     Unit :  kN.,  m.
           -. P-M calculation method : Keep P constant
          -----------------------------------------------------
           Trial          c       Phi*Pn       Pu       Ratio
          -----------------------------------------------------
            1-st      0.180       181.12     135.894     75.03
            2-nd      0.173       105.60     135.894     71.32
            3-rd      0.176       143.55     135.894     94.67
            4-th      0.175       124.63     135.894     90.96
            5-th      0.176       134.10     135.894     98.66
            6-th      0.176       138.83     135.894     97.89
            7-th      0.176       136.46     135.894     99.58
          -----------------------------------------------------

      ( ). Compute capacity of compression stress block.
           -. a      = beta1*c                =       0.149 m.
           -. Acom                            =       0.022 m^2.
           -. DCcy                            =       0.130 m.
           -. DCcz                            =       0.129 m.
           -. Cc     = 0.85*fc*Acom           =      531.08 kN.
           -. MnCy   = Cc*DCcz                =       68.60 kN-m.
           -. MnCz   = Cc*DCcy                =       69.04 kN-m.

      ( ). Compute capacity of reinforcement.
      -------------------------------------------------------------------------------------------------
       i      dsi       esi         fsi         Asi         Fsi      dzi        MnPyi      dyi       MnPzi
      -------------------------------------------------------------------------------------------------
       1    0.509 -0.005691 -420000.00  5.097e-04    -214.06   -0.160       34.25   -0.160       34.25
       2    0.284 -0.001851 -370228.61  5.097e-04    -188.70    0.160      -30.19   -0.160       30.19
       3    0.057  0.002034  406864.28  5.097e-04     207.37    0.160       33.18    0.160       33.18
       4    0.282 -0.001806 -361128.57  5.097e-04    -184.06   -0.160       29.45    0.160      -29.45
      -------------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ----------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =     -379.45 kN.
```

```
-. MnPy   = SUM [ MnPyi ]  =       66.69 kN-m.
-. MnPz   = SUM [ MnPzi ]  =       68.17 kN-m.
```

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-----------------------------------------------------------------------------------------
 midas Gen - RC-Column Design   [ NSR-10 ]                                    Gen 2022
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      ( ). Compute nominal capacity(Pn,Mn) of given neutral axis.
           -. Pn      = Cc + Ps                =      151.63 kN.
           -. Mny     = MnCy + MnPy            =      135.28 kN-m.
           -. Mnz     = MnCz + MnPz            =      137.21 kN-m.
           -. Mn      = SQRT(Mny^2+Mnz^2)      =      192.69 kN-m.

      ( ). Compute strength reduction factor.
           -. et       = 0.00569
           -. et_min  = 0.00210
           -. et_max  = 0.00500
           -. et > et_max  --->  phi =0.900

      ( ). Compute axial load and moment capacities(phiPn,phiMn).
           -. phiPn  = phi*Pn  =      136.46 kN.
           -. phiMn  = phi*Mn  =      173.42 kN-m.
           -. phiMny = phi*Mny =      121.76 kN-m.
           -. phiMnz = phi*Mnz =      123.49 kN-m.

      ( ). Check ratios of axial load and moment capacity.
           -. Rat_P  = Pu/phiPn = 0.996  <  1.000  --->  O.K.
           -. Rat_M  = Mc/phiMn = 0.314  <  1.000  --->  O.K.

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

      ( ). Compute maximum spacing of ties.
           -. smax    = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   28,  POS = J )
           -. Applied axial force : Pu  =      135.90 kN.
           -. Applied shear force : Vuz =       21.33 kN.
           -. d       = Hc-do     =    0.360 m.
           -. Bw      = Bc        =    0.400 m.
           -. Acv     = Bw*d      =    0.144 m^2.
           -. Vc      = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      137.39 kN.
           -. phi     = 0.75
           -. phiVc   = phi*Vc    =      103.05 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   28,  POS = J )
           -. Applied axial force : Pu  =      135.90 kN.
           -. Applied shear force : Vuy =       20.92 kN.
           -. d       = Bc-do     =    0.360 m.
           -. Bw      = Hc        =    0.400 m.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      137.39 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      103.05 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   28,  POS = 1/2 )
           -. Applied axial force : Pu  =      142.81 kN.
           -. Applied shear force : Vuz =       21.33 kN.
           -. d      = Hc-do    =    0.360 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      137.79 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      103.35 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   28,  POS = 1/2 )
           -. Applied axial force : Pu  =      142.81 kN.
           -. Applied shear force : Vuy =       20.92 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      137.79 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      103.35 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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      *.midas Gen - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = COLUMN ,  MEMB =     9,  LCB =   28,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     1) : C40*40
        Section Type : Rectangular with Ties (RT)
        Section Height (HTc)            =         4.000 m.
        Section Depth  (Hc)             =         0.400 m.
        Section Width  (Bc)             =         0.400 m.
        Concrete Cover to C.O.R. (do)   =         0.040 m.
        Concrete Strength (fc)          =     28000.000 KPa.
        Modulus of Elasticity (Ec)      =  24870062.324 KPa.
        Main Rebar Strength (fy)        =    420000.000 KPa.
        Ties/Spirals Strength (fys)     =    420000.000 KPa.
        Modulus of Elasticity (Es)      = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

     *.REBAR PATTERN = RT -  4 -  2 - #8          Unit :  m.
        --------------------------------------------------------
           i          dyi          dzi      Rebar          Asi
        --------------------------------------------------------
           1       -0.160       -0.160      1-#8       0.00051
           2       -0.160        0.160      1-#8       0.00051
           3        0.160        0.160      1-#8       0.00051
           4        0.160       -0.160      1-#8       0.00051
        --------------------------------------------------------

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

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =   28
           ------------------------------------------------------------------------------
            Load Case               Pu           Myi           Myj           Mzi           Mzj
           ------------------------------------------------------------------------------
            DL                  104.24          1.28         -2.19         -1.39          2.30
            LL                   -0.00          0.00          0.00          0.00          0.00
            DL+LL               104.24          1.28         -2.19         -1.39          2.30
            Others               81.00         27.09         41.05         24.83         45.78
           ------------------------------------------------------------------------------
            DL+LL+Others        185.24         28.36         38.86         23.44         48.08
           ------------------------------------------------------------------------------
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                   Gen 2022
============================================================================================

      ( ). Compute member end moments(M1,M2).  Unit : kN-m.
           -. For Dead Load(DL).
              My1D =          1.28,   My2D =          2.19
              Mz1D =          1.39,   Mz2D =          2.30
           -. For Gravity Load(DL+LL).
              My1G =          1.28,   My2G =          2.19
              Mz1G =          1.39,   Mz2G =          2.30
           -. For Total Load(DL+LL+WL(EL)).
              My1  =         28.36,   My2  =         38.86
              Mz1  =         23.44,   Mz2  =         48.08

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. Slenderness ratio limits.
              SRy(Braced)   =  34 - 12*| My1/My2 | =   25.240  (Single curvature)
              SRz(Braced)   =  34 - 12*| Mz1/Mz2 | =   28.151  (Single curvature)
           -. Radii of gyration.
              ry     =  0.30*Hc  =    0.120 m.
              rz     =  0.30*Bc  =    0.120 m.
           -. Unbraced lengths.
              Ly     =    4.000 m.
              Lz     =    4.000 m.
           -. Effective length factors.
              Ky     =    1.000
              Kz     =    1.000
           -. SLENy  =  Ky*Ly/ry  =   33.333  >  SRy  --->  SLENDER.
           -. SLENz  =  Kz*Lz/rz  =   33.333  >  SRz  --->  SLENDER.

      ( ). Compute moment magnification factors for major axis(DBy,DSy).
           -. Ec       =  4700*SQRT[fc]                    =  2.4870e+07 KPa.
           -. Ryy      =  Bc*Hc^3/12                       =        0.0021 m^4.
           -. Rse                                          =    5.2273e-05 m^4.
           -. Betadnsy =  Pu_D/Pu                          =   0.5627
           -. EIy      =  (0.2*Ec*Ryy+Es*Rse)/(1+Betadnsy) =    13480.1204 (by N, mm).
           -. Pu       =  Pu_G + Pu_S           =       185.24 kN.
           -. Single Curvature Bending.
           -. Cmy      =        0.85 (Default or User defined value)
           -. Pcy      =  (pi^2*EIy)/(Ky*Ly)^2  =     8315.22 kN.
           -. DBy      =  Cmy/(1-Pu/(0.75*Pcy)) =        0.88
           -. DBy  <  1.0  --->  DBy  =  1.00
           -. DSy    =     1.00 (Default value)

      ( ). Compute moment magnification factors for minor axis(DBz,DSz).
           -. Ec       =  4700*SQRT[fc]                    =  2.4870e+07 KPa.
           -. Rzz      =  Hc*Bc^3/12                       =        0.0021 m^4.
           -. Rse                                          =    5.2273e-05 m^4.
           -. Betadnsz =  Pu_D/Pu                          =   0.5627
           -. EIz      =  (0.2*Ec*Rzz+Es*Rse)/(1+Betadnsz) =    13480.1204 (by N, mm).
```

PROJECT TITLE :	Acueducto Agua Bonita San José del Guaviare		
Company	Leandro Castellanos	Client	
Author	Leandro Castellanos	File Name	Tanque Elevado.rcs

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 midas Gen - RC-Column Design   [ NSR-10 ]                                      Gen 2022
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           -. Pu       =  Pu_G + Pu_S           =      185.24 kN.
           -. Single Curvature Bending.
           -. Cmz      =        0.85 (Default or User defined value)
           -. Pcz      =  (pi^2*EIz)/(Kz*Lz)^2  =     8315.22 kN.
           -. DBz      =  Cmz/(1-Pu/(0.75*Pcz)) =        0.88
           -. DBz  <  1.0  --->  DBz  =  1.00
           -. DSz    =     1.00 (Default value)

      ( ). Compute minimum moments(Mmin).
           -. emin_y  =  15 mm. + 0.03*Hc    =       0.027 m.
           -. emin_z  =  15 mm. + 0.03*Bc    =       0.027 m.
           -. Mmin_y  =  Pu * emin_y         =        5.00 kN-m.
           -. Mmin_z  =  Pu * emin_z         =        5.00 kN-m.

      ( ). Compute magnified moments. (Pos : J, Local-y : Braced, Local-z : Braced).
           -. No sidesway moments.
              QMb_y  =  My_G   =       -2.19 kN-m.
              QMb_z  =  Mz_G   =        2.30 kN-m.
           -. Sidesway moments.
              QMs_y  =  My_S   =       41.05 kN-m.
              QMs_z  =  Mz_S   =       45.78 kN-m.
           -. Compute magnified moments(Mcy,Mcz).
              Mcy(Slender)    =  DBy*MAX(Mmin_y, QMb_y+QMs_y)     =       38.86 kN-m.
              Mcz(Slender)    =  DBz*MAX(Mmin_z, QMb_z+QMs_z)     =       48.08 kN-m.

      ( ). Check total moment including 2nd-order effects.
           -. Moments due to 1st-order effects.
              Mcy-1st =         38.86 kN-m.
              Mcz-1st =         48.08 kN-m.
           -. Moments due to 2nd-order effects.
              Mcy-2nd = DBy*(QMb_y + QMs_y) =        38.86 kN-m.
              Mcz-2nd = DBz*(QMb_z + QMs_z) =        48.08 kN-m.
           -. Ratio of moment due to 2nd-order effects to moment due to 1st-order effects.
              Mcy-2nd / Mcy-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.
              Mcz-2nd / Mcz-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.

      ( ). Design forces/moments of column(brace).
           -. Axial Force (Compression)      Pu   =      185.24 kN.
           -. Combined Bending Moment        Mc   =       61.82 kN-m.
           -. Bending Moment about Local-y   Mcy =       38.86 kN-m.
           -. Bending Moment about Local-z   Mcz =       48.08 kN-m.
           -. Shear Force of Local-y         Vuy =       21.52 kN.
           -. Shear Force of Local-z         Vuz =       21.45 kN.

 ===============================================================================
   [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC_COLUMN(RC-BRACE).
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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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      ( ). Compute design parameters.
           -. Ag     =              0.1600 m^2.
           -. Ast    =              0.0020 m^2.
           -. Rhot   = Ast/Ag =   0.012742
           -. esu    = fy/Es  =   0.002100
           -. beta1  =   0.8500  ( fc < 28 MPa.)

      ( ). Check the ratio of reinforcement.
           -. Rhomin =   0.010000
           -. Rhomax =   0.040000
           -. Rhot   =   0.012742
              Rhomin < Rhot < Rhomax  --->  O.K !

      ( ). Compute eccentricities of biaxially loaded column.
           -. Ecny   = ABS(Mcz/Pu)     =      0.2596 m.
           -. Ecnz   = ABS(Mcy/Pu)     =      0.2098 m.
           -. Eccn   = ABS(Mc/Pu)      =      0.3337 m.
           -. Rota   = ATAN(Ecny/Ecnz) =     51.0582 deg.
           -. Rotation of neutral axis =     51.0582 deg.

      ( ). Compute concentric axial load capacity.
           -. Po     = (0.85*fc)*(Ag-Ast) + fy*Ast    =     4615.74 kN.
           -. Maximum Axial Load    : Pomax = 0.75*Po =     3461.80 kN.
           -. Maximum Axial Tension : Pt    = -fy*Ast =     -856.26 kN.

     ----------------------------------------------------------------------------
       *. Analysis of balanced condition.
     ----------------------------------------------------------------------------

      ( ). Compute capacity of concrete stress block.
           -. cb     = (0.003/(0.003+esu))*d  =       0.298 m.
           -. ab     = beta1*cb               =       0.253 m.
           -. Acom                            =       0.066 m^2.
           -. DCcy                            =       0.092 m.
           -. DCcz                            =       0.066 m.
           -. Cc     = 0.85*fc*Acom           =     1559.74 kN.
           -. MnCy   = Cc*DCcz                =      102.58 kN-m.
           -. MnCz   = Cc*DCcy                =      142.73 kN-m.

      ( ). Compute capacity of reinforcement.
```

i	dsi	esi	fsi	Asi	Fsi	dzi	MnPyi	dyi	MnPzi
1	0.506	-0.002100	-420000.00	5.097e-04	-214.06	-0.160	34.25	-0.160	34.25
2	0.305	-0.000074	-14779.85	5.097e-04	-7.53	0.160	-1.21	-0.160	1.21
3	0.056	0.002433	420000.00	5.097e-04	214.06	0.160	34.25	0.160	34.25
4	0.257	0.000407	81446.52	5.097e-04	41.51	-0.160	-6.64	0.160	6.64

```
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ----------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =       33.98 kN.
```

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-. MnPy   = SUM [ MnPyi ]  =       60.65 kN-m.
-. MnPz   = SUM [ MnPzi ]  =       76.35 kN-m.
```

midas Gen - RC-Column Design [NSR-10] Gen 2022

( ). Compute nominal capacity(Pb,Mb) of Balanced Condition.
- -. Pb = Cc + Ps = 1593.72 kN.
- -. Mny = MnCy + MnPy = 163.23 kN-m.
- -. Mnz = MnCz + MnPz = 219.08 kN-m.
- -. Mb = SQRT(Mny^2+Mnz^2) = 273.20 kN-m.

( ). Compare actual eccentricity with balanced eccentricity.
- -. Balanced eccentricity : eb = Mb/Pb = 0.171 m.
- -. Minimum eccentricity : Emin (not defined) = 0.000 m.
- -. Actual eccentricity : Eccn = Mu/Pu = 0.334 m.
- -. eb < Eccn ---> Tension controls.

*. Final analysis with searched neutral axis.

( ). Search for neutral axis...... Unit : kN., m.
- -. P-M calculation method : Keep P constant

Trial	c	Phi*Pn	Pu	Ratio
1-st	0.179	188.57	185.241	98.23
2-nd	0.172	131.33	185.241	58.95
3-rd	0.175	159.95	185.241	84.19
4-th	0.177	174.26	185.241	93.70
5-th	0.178	181.41	185.241	97.89
6-th	0.178	184.99	185.241	99.87
7-th	0.179	186.78	185.241	99.18
8-th	0.179	185.89	185.241	99.65

( ). Compute capacity of compression stress block.
- -. a = beta1*c = 0.152 m.
- -. Acom = 0.024 m^2.
- -. DCcy = 0.135 m.
- -. DCcz = 0.120 m.
- -. Cc = 0.85*fc*Acom = 560.37 kN.
- -. MnCy = Cc*DCcz = 66.98 kN-m.
- -. MnCz = Cc*DCcy = 75.64 kN-m.

( ). Compute capacity of reinforcement.

i	dsi	esi	fsi	Asi	Fsi	dzi	MnPyi	dyi	MnPzi
1	0.506	-0.005509	-420000.00	5.097e-04	-214.06	-0.160	34.25	-0.160	34.25
2	0.305	-0.002128	-420000.00	5.097e-04	-214.06	0.160	-34.25	-0.160	34.25
3	0.056	0.002055	410916.16	5.097e-04	209.43	0.160	33.51	0.160	33.51
4	0.257	-0.001326	-265147.80	5.097e-04	-135.14	-0.160	21.62	0.160	-21.62

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ------------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =     -353.83 kN.
           -. MnPy   = SUM [ MnPyi ]  =       55.13 kN-m.
           -. MnPz   = SUM [ MnPzi ]  =       80.39 kN-m.

      ( ). Compute nominal capacity(Pn,Mn) of given neutral axis.
           -. Pn     = Cc + Ps                 =      206.54 kN.
           -. Mny    = MnCy + MnPy             =      122.12 kN-m.
           -. Mnz    = MnCz + MnPz             =      156.02 kN-m.
           -. Mn     = SQRT(Mny^2+Mnz^2)       =      198.13 kN-m.

      ( ). Compute strength reduction factor.
           -. et       = 0.00551
           -. et_min  = 0.00210
           -. et_max  = 0.00500
           -. et > et_max  --->  phi =0.900

      ( ). Compute axial load and moment capacities(phiPn,phiMn).
           -. phiPn  = phi*Pn  =      185.89 kN.
           -. phiMn  = phi*Mn  =      178.32 kN-m.
           -. phiMny = phi*Mny =      109.90 kN-m.
           -. phiMnz = phi*Mnz =      140.42 kN-m.

      ( ). Check ratios of axial load and moment capacity.
           -. Rat_P  = Pu/phiPn = 0.997  <  1.000  --->  O.K.
           -. Rat_M  = Mc/phiMn = 0.347  <  1.000  --->  O.K.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   15,  POS = J )
           -. Applied axial force : Pu  =      219.98 kN.
           -. Applied shear force : Vuz =       21.45 kN.
           -. d      = Hc-do    =    0.360 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      142.26 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      106.69 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                   Gen 2022
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      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   19,  POS = J )
           -. Applied axial force : Pu  =      238.86 kN.
           -. Applied shear force : Vuy =       21.52 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      143.35 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      107.51 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   15,  POS = 1/2 )
           -. Applied axial force : Pu  =      229.20 kN.
           -. Applied shear force : Vuz =       21.45 kN.
           -. d      = Hc-do    =    0.360 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      142.79 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      107.09 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   19,  POS = 1/2 )
           -. Applied axial force : Pu  =      248.08 kN.
           -. Applied shear force : Vuy =       21.52 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      143.88 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      107.91 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      *.midas Gen - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = COLUMN ,  MEMB =    10,  LCB =   26,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     1) : C40*40
        Section Type : Rectangular with Ties (RT)
        Section Height (HTc)            =        4.000 m.
        Section Depth  (Hc)             =        0.400 m.
        Section Width  (Bc)             =        0.400 m.
        Concrete Cover to C.O.R. (do)   =        0.040 m.
        Concrete Strength (fc)          =    28000.000 KPa.
        Modulus of Elasticity (Ec)      =  24870062.324 KPa.
        Main Rebar Strength (fy)        =   420000.000 KPa.
        Ties/Spirals Strength (fys)     =   420000.000 KPa.
        Modulus of Elasticity (Es)      = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

     *.REBAR PATTERN = RT -  4 -  2 - #8          Unit :  m.
        --------------------------------------------------------
           i          dyi          dzi      Rebar          Asi
        --------------------------------------------------------
           1       -0.160       -0.160      1-#8       0.00051
           2       -0.160        0.160      1-#8       0.00051
           3        0.160        0.160      1-#8       0.00051
           4        0.160       -0.160      1-#8       0.00051
        --------------------------------------------------------

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

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =   26
           ------------------------------------------------------------------------------
            Load Case              Pu           Myi           Myj           Mzi           Mzj
           ------------------------------------------------------------------------------
            DL                 159.57          0.32         -0.60          0.37         -0.62
            LL                  -0.00          0.00          0.00          0.00          0.00
            DL+LL              159.57          0.32         -0.60          0.37         -0.62
            Others             -62.76         48.23         27.49         48.26         27.46
           ------------------------------------------------------------------------------
            DL+LL+Others        96.81         48.55         26.88         48.63         26.84
           ------------------------------------------------------------------------------
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute member end moments(M1,M2).  Unit : kN-m.
           -. For Dead Load(DL).
              My1D =         0.32,   My2D =         0.60
              Mz1D =         0.37,   Mz2D =         0.62
           -. For Gravity Load(DL+LL).
              My1G =         0.32,   My2G =         0.60
              Mz1G =         0.37,   Mz2G =         0.62
           -. For Total Load(DL+LL+WL(EL)).
              My1  =        26.88,   My2  =        48.55
              Mz1  =        26.84,   Mz2  =        48.63

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. Slenderness ratio limits.
              SRy(Braced)    =  34 - 12*| My1/My2 | =   27.356  (Single curvature)
              SRz(Braced)    =  34 - 12*| Mz1/Mz2 | =   27.377  (Single curvature)
           -. Radii of gyration.
              ry     =  0.30*Hc  =    0.120 m.
              rz     =  0.30*Bc  =    0.120 m.
           -. Unbraced lengths.
              Ly     =    4.000 m.
              Lz     =    4.000 m.
           -. Effective length factors.
              Ky     =    1.000
              Kz     =    1.000
           -. SLENy  =  Ky*Ly/ry  =   33.333  >  SRy  --->  SLENDER.
           -. SLENz  =  Kz*Lz/rz  =   33.333  >  SRz  --->  SLENDER.

      ( ). Compute moment magnification factors for major axis(DBy,DSy).
           -. Ec       =  4700*SQRT[fc]                  =  2.4870e+07 KPa.
           -. Ryy      =  Bc*Hc^3/12                     =        0.0021 m^4.
           -. Rse                                        =    5.2273e-05 m^4.
           -. Betadnsy =  Pu_D/Pu                        =   1.0000
           -. EIy      =  (0.2*Ec*Ryy+Es*Rse)/(1+Betadnsy) =    10532.8723 (by N, mm).
           -. Pu       =  Pu_G + Pu_S           =        96.81 kN.
           -. Single Curvature Bending.
           -. Cmy      =          0.85 (Default or User defined value)
           -. Pcy      =  (pi^2*EIy)/(Ky*Ly)^2  =     6497.21 kN.
           -. DBy      =  Cmy/(1-Pu/(0.75*Pcy)) =        0.87
           -. DBy  <  1.0   --->  DBy   =  1.00
           -. DSy    =     1.00 (Default value)

      ( ). Compute moment magnification factors for minor axis(DBz,DSz).
           -. Ec       =  4700*SQRT[fc]                  =  2.4870e+07 KPa.
           -. Rzz      =  Hc*Bc^3/12                     =        0.0021 m^4.
           -. Rse                                        =    5.2273e-05 m^4.
           -. Betadnsz =  Pu_D/Pu                        =   1.0000
           -. EIz      =  (0.2*Ec*Rzz+Es*Rse)/(1+Betadnsz) =    10532.8723 (by N, mm).
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           -. Pu       =  Pu_G + Pu_S           =       96.81 kN.
           -. Single Curvature Bending.
           -. Cmz      =        0.85 (Default or User defined value)
           -. Pcz      =  (pi^2*EIz)/(Kz*Lz)^2  =     6497.21 kN.
           -. DBz      =  Cmz/(1-Pu/(0.75*Pcz)) =        0.87
           -. DBz  <  1.0  --->  DBz  =  1.00
           -. DSz    =     1.00 (Default value)

      ( ). Compute minimum moments(Mmin).
           -. emin_y  =  15 mm. + 0.03*Hc    =       0.027 m.
           -. emin_z  =  15 mm. + 0.03*Bc    =       0.027 m.
           -. Mmin_y  =  Pu * emin_y         =        2.61 kN-m.
           -. Mmin_z  =  Pu * emin_z         =        2.61 kN-m.

      ( ). Compute magnified moments. (Pos : I, Local-y : Braced, Local-z : Braced).
           -. No sidesway moments.
              QMb_y  =  My_G   =        0.32 kN-m.
              QMb_z  =  Mz_G   =        0.37 kN-m.
           -. Sidesway moments.
              QMs_y  =  My_S   =       48.23 kN-m.
              QMs_z  =  Mz_S   =       48.26 kN-m.
           -. Compute magnified moments(Mcy,Mcz).
              Mcy(Slender)    =  DBy*MAX(Mmin_y, QMb_y+QMs_y)     =       48.55 kN-m.
              Mcz(Slender)    =  DBz*MAX(Mmin_z, QMb_z+QMs_z)     =       48.63 kN-m.

      ( ). Check total moment including 2nd-order effects.
           -. Moments due to 1st-order effects.
              Mcy-1st =        48.55 kN-m.
              Mcz-1st =        48.63 kN-m.
           -. Moments due to 2nd-order effects.
              Mcy-2nd = DBy*(QMb_y + QMs_y) =        48.55 kN-m.
              Mcz-2nd = DBz*(QMb_z + QMs_z) =        48.63 kN-m.
           -. Ratio of moment due to 2nd-order effects to moment due to 1st-order effects.
              Mcy-2nd / Mcy-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.
              Mcz-2nd / Mcz-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.

      ( ). Design forces/moments of column(brace).
           -. Axial Force (Compression)      Pu   =       96.81 kN.
           -. Combined Bending Moment        Mc   =       68.72 kN-m.
           -. Bending Moment about Local-y   Mcy =        48.55 kN-m.
           -. Bending Moment about Local-z   Mcz =        48.63 kN-m.
           -. Shear Force of Local-y         Vuy =        21.26 kN.
           -. Shear Force of Local-z         Vuz =        21.23 kN.

 ===============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC_COLUMN(RC-BRACE).
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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute design parameters.
           -. Ag     =              0.1600 m^2.
           -. Ast    =              0.0020 m^2.
           -. Rhot   = Ast/Ag =   0.012742
           -. esu    = fy/Es  =   0.002100
           -. beta1  =   0.8500  ( fc < 28 MPa.)

      ( ). Check the ratio of reinforcement.
           -. Rhomin =   0.010000
           -. Rhomax =   0.040000
           -. Rhot   =   0.012742
              Rhomin < Rhot < Rhomax  --->  O.K !

      ( ). Compute eccentricities of biaxially loaded column.
           -. Ecny   = ABS(Mcz/Pu)     =      0.5023 m.
           -. Ecnz   = ABS(Mcy/Pu)     =      0.5016 m.
           -. Eccn   = ABS(Mc/Pu)      =      0.7099 m.
           -. Rota   = ATAN(Ecny/Ecnz) =     45.0440 deg.
           -. Rotation of neutral axis =     45.0440 deg.

      ( ). Compute concentric axial load capacity.
           -. Po     = (0.85*fc)*(Ag-Ast) + fy*Ast    =     4615.74 kN.
           -. Maximum Axial Load    : Pomax = 0.75*Po =     3461.80 kN.
           -. Maximum Axial Tension : Pt    = -fy*Ast =     -856.26 kN.

     ----------------------------------------------------------------------------
       *. Analysis of balanced condition.
     ----------------------------------------------------------------------------

      ( ). Compute capacity of concrete stress block.
           -. cb     = (0.003/(0.003+esu))*d  =       0.299 m.
           -. ab     = beta1*cb               =       0.255 m.
           -. Acom                            =       0.065 m^2.
           -. DCcy                            =       0.080 m.
           -. DCcz                            =       0.080 m.
           -. Cc     = 0.85*fc*Acom           =     1542.24 kN.
           -. MnCy   = Cc*DCcz                =      123.24 kN-m.
           -. MnCz   = Cc*DCcy                =      123.52 kN-m.

      ( ). Compute capacity of reinforcement.
```

i	dsi	esi	fsi	Asi	Fsi	dzi	MnPyi	dyi	MnPzi
1	0.509	-0.002100	-420000.00	5.097e-04	-214.06	-0.160	34.25	-0.160	34.25
2	0.283	0.000165	32985.23	5.097e-04	16.81	0.160	2.69	-0.160	-2.69
3	0.057	0.002433	420000.00	5.097e-04	214.06	0.160	34.25	0.160	34.25
4	0.283	0.000168	33681.43	5.097e-04	17.17	-0.160	-2.75	0.160	2.75

```
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ----------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =       33.98 kN.
```

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-. MnPy   = SUM [ MnPyi ]  =       68.44 kN-m.
-. MnPz   = SUM [ MnPzi ]  =       68.56 kN-m.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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      ( ). Compute nominal capacity(Pb,Mb) of Balanced Condition.
           -. Pb      = Cc + Ps                =      1576.22 kN.
           -. Mny     = MnCy + MnPy            =       191.68 kN-m.
           -. Mnz     = MnCz + MnPz            =       192.08 kN-m.
           -. Mb      = SQRT(Mny^2+Mnz^2)      =       271.36 kN-m.

      ( ). Compare actual eccentricity with balanced eccentricity.
           -. Balanced eccentricity : eb   = Mb/Pb        =    0.172 m.
           -. Minimum eccentricity  : Emin (not defined)  =    0.000 m.
           -. Actual eccentricity   : Eccn = Mu/Pu        =    0.710 m.
           -. eb   < Eccn       --->  Tension controls.

     ---------------------------------------------------------------------------
       *. Final analysis with searched neutral axis.
     ---------------------------------------------------------------------------

      ( ). Search for neutral axis......     Unit :  kN.,  m.
           -. P-M calculation method : Keep P constant
          -----------------------------------------------------
           Trial          c       Phi*Pn       Pu       Ratio
          -----------------------------------------------------
            1-st      0.180       181.10      96.806     53.45
            2-nd      0.173       105.59      96.806     91.68
            3-rd      0.169        67.22      96.806     56.00
            4-th      0.171        86.46      96.806     88.04
            5-th      0.172        96.04      96.806     99.20
            6-th      0.173       100.82      96.806     96.02
            7-th      0.172        98.43      96.806     98.35
            8-th      0.172        97.23      96.806     99.56
          -----------------------------------------------------

      ( ). Compute capacity of compression stress block.
           -. a       = beta1*c                =        0.146 m.
           -. Acom                             =        0.021 m^2.
           -. DCcy                             =        0.131 m.
           -. DCcz                             =        0.131 m.
           -. Cc      = 0.85*fc*Acom           =       509.82 kN.
           -. MnCy    = Cc*DCcz                =        66.76 kN-m.
           -. MnCz    = Cc*DCcy                =        66.82 kN-m.

      ( ). Compute capacity of reinforcement.
      -----------------------------------------------------------------------------------------------
       i      dsi       esi         fsi         Asi          Fsi      dzi        MnPyi       dyi       MnPzi
      -----------------------------------------------------------------------------------------------
       1    0.509 -0.005870 -420000.00  5.097e-04    -214.06   -0.160       34.25   -0.160       34.25
       2    0.283 -0.001931 -386197.41  5.097e-04    -196.84    0.160      -31.49   -0.160       31.49
       3    0.057  0.002014  402881.61  5.097e-04     205.34    0.160       32.85    0.160       32.85
       4    0.283 -0.001925 -384986.53  5.097e-04    -196.22   -0.160       31.39    0.160      -31.39
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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ------------------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ---------------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =     -401.78 kN.
           -. MnPy   = SUM [ MnPyi ]  =       67.01 kN-m.
           -. MnPz   = SUM [ MnPzi ]  =       67.20 kN-m.

      ( ). Compute nominal capacity(Pn,Mn) of given neutral axis.
           -. Pn     = Cc + Ps               =      108.04 kN.
           -. Mny    = MnCy + MnPy           =      133.77 kN-m.
           -. Mnz    = MnCz + MnPz           =      134.02 kN-m.
           -. Mn     = SQRT(Mny^2+Mnz^2)     =      189.35 kN-m.

      ( ). Compute strength reduction factor.
           -. et       = 0.00587
           -. et_min  = 0.00210
           -. et_max  = 0.00500
           -. et > et_max  --->  phi =0.900

      ( ). Compute axial load and moment capacities(phiPn,phiMn).
           -. phiPn  = phi*Pn  =       97.23 kN.
           -. phiMn  = phi*Mn  =      170.42 kN-m.
           -. phiMny = phi*Mny =      120.39 kN-m.
           -. phiMnz = phi*Mnz =      120.62 kN-m.

      ( ). Check ratios of axial load and moment capacity.
           -. Rat_P  = Pu/phiPn = 0.996  <  1.000  --->  O.K.
           -. Rat_M  = Mc/phiMn = 0.403  <  1.000  --->  O.K.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   25,  POS = J )
           -. Applied axial force : Pu  =       82.98 kN.
           -. Applied shear force : Vuz =       21.23 kN.
           -. d      = Hc-do    =    0.360 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      134.33 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      100.75 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   28,  POS = J )
           -. Applied axial force : Pu  =       82.99 kN.
           -. Applied shear force : Vuy =       21.26 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      134.34 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      100.75 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   25,  POS = 1/2 )
           -. Applied axial force : Pu  =       89.89 kN.
           -. Applied shear force : Vuz =       21.23 kN.
           -. d      = Hc-do    =    0.360 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      134.73 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      101.05 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   28,  POS = 1/2 )
           -. Applied axial force : Pu  =       89.90 kN.
           -. Applied shear force : Vuy =       21.26 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      134.73 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      101.05 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      *.midas Gen - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = COLUMN ,  MEMB =    11,  LCB =   27,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     1) : C40*40
        Section Type : Rectangular with Ties (RT)
        Section Height (HTc)            =        4.000 m.
        Section Depth  (Hc)             =        0.400 m.
        Section Width  (Bc)             =        0.400 m.
        Concrete Cover to C.O.R. (do)   =        0.040 m.
        Concrete Strength (fc)          =    28000.000 KPa.
        Modulus of Elasticity (Ec)      =  24870062.324 KPa.
        Main Rebar Strength (fy)        =   420000.000 KPa.
        Ties/Spirals Strength (fys)     =   420000.000 KPa.
        Modulus of Elasticity (Es)      = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

     *.REBAR PATTERN = RT -  4 -  2 - #8          Unit :  m.
        --------------------------------------------------------
           i          dyi          dzi      Rebar          Asi
        --------------------------------------------------------
           1       -0.160       -0.160      1-#8       0.00051
           2       -0.160        0.160      1-#8       0.00051
           3        0.160        0.160      1-#8       0.00051
           4        0.160       -0.160      1-#8       0.00051
        --------------------------------------------------------

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

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =   27
           ------------------------------------------------------------------------------
            Load Case               Pu           Myi           Myj           Mzi           Mzj
           ------------------------------------------------------------------------------
            DL                  139.81          0.64         -0.45          0.68         -0.48
            LL                   -0.00          0.00          0.00          0.00          0.00
            DL+LL               139.81          0.64         -0.45          0.68         -0.48
            Others               10.23         38.29         38.83         38.33         38.80
           ------------------------------------------------------------------------------
            DL+LL+Others        150.04         38.93         38.38         39.00         38.33
           ------------------------------------------------------------------------------
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 midas Gen - RC-Column Design   [ NSR-10 ]                                   Gen 2022
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      ( ). Compute member end moments(M1,M2).  Unit : kN-m.
           -. For Dead Load(DL).
              My1D =         0.45,   My2D =         0.64
              Mz1D =         0.48,   Mz2D =         0.68
           -. For Gravity Load(DL+LL).
              My1G =         0.45,   My2G =         0.64
              Mz1G =         0.48,   Mz2G =         0.68
           -. For Total Load(DL+LL+WL(EL)).
              My1  =        38.38,   My2  =        38.93
              Mz1  =        38.33,   Mz2  =        39.00

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. Slenderness ratio limits.
              SRy(Braced)   =  34 - 12*| My1/My2 | =   22.168  (Single curvature)
              SRz(Braced)   =  34 - 12*| Mz1/Mz2 | =   22.208  (Single curvature)
           -. Radii of gyration.
              ry     =  0.30*Hc  =    0.120 m.
              rz     =  0.30*Bc  =    0.120 m.
           -. Unbraced lengths.
              Ly     =    4.000 m.
              Lz     =    4.000 m.
           -. Effective length factors.
              Ky     =    1.000
              Kz     =    1.000
           -. SLENy  =  Ky*Ly/ry  =   33.333  >  SRy  --->  SLENDER.
           -. SLENz  =  Kz*Lz/rz  =   33.333  >  SRz  --->  SLENDER.

      ( ). Compute moment magnification factors for major axis(DBy,DSy).
           -. Ec       =  4700*SQRT[fc]                  =  2.4870e+07 KPa.
           -. Ryy      =  Bc*Hc^3/12                     =        0.0021 m^4.
           -. Rse                                        =    5.2273e-05 m^4.
           -. Betadnsy =  Pu_D/Pu                        =   0.9318
           -. EIy      =  (0.2*Ec*Ryy+Es*Rse)/(1+Betadnsy) =    10904.7917 (by N, mm).
           -. Pu       =  Pu_G + Pu_S          =      150.04 kN.
           -. Single Curvature Bending.
           -. Cmy      =         0.85 (Default or User defined value)
           -. Pcy      =  (pi^2*EIy)/(Ky*Ly)^2  =     6726.62 kN.
           -. DBy      =  Cmy/(1-Pu/(0.75*Pcy)) =        0.88
           -. DBy  <  1.0  --->  DBy  =  1.00
           -. DSy    =     1.00 (Default value)

      ( ). Compute moment magnification factors for minor axis(DBz,DSz).
           -. Ec       =  4700*SQRT[fc]                  =  2.4870e+07 KPa.
           -. Rzz      =  Hc*Bc^3/12                     =        0.0021 m^4.
           -. Rse                                        =    5.2273e-05 m^4.
           -. Betadnsz =  Pu_D/Pu                        =   0.9318
           -. EIz      =  (0.2*Ec*Rzz+Es*Rse)/(1+Betadnsz) =    10904.7917 (by N, mm).
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                    Gen 2022
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           -. Pu       =  Pu_G + Pu_S           =      150.04 kN.
           -. Single Curvature Bending.
           -. Cmz      =         0.85 (Default or User defined value)
           -. Pcz      =  (pi^2*EIz)/(Kz*Lz)^2  =     6726.62 kN.
           -. DBz      =  Cmz/(1-Pu/(0.75*Pcz)) =        0.88
           -. DBz  <  1.0  --->  DBz  =  1.00
           -. DSz    =     1.00 (Default value)

      ( ). Compute minimum moments(Mmin).
           -. emin_y  =  15 mm. + 0.03*Hc    =       0.027 m.
           -. emin_z  =  15 mm. + 0.03*Bc    =       0.027 m.
           -. Mmin_y  =  Pu * emin_y         =        4.05 kN-m.
           -. Mmin_z  =  Pu * emin_z         =        4.05 kN-m.

      ( ). Compute magnified moments. (Pos : I, Local-y : Braced, Local-z : Braced).
           -. No sidesway moments.
              QMb_y  =  My_G   =        0.64 kN-m.
              QMb_z  =  Mz_G   =        0.68 kN-m.
           -. Sidesway moments.
              QMs_y  =  My_S   =       38.29 kN-m.
              QMs_z  =  Mz_S   =       38.33 kN-m.
           -. Compute magnified moments(Mcy,Mcz).
              Mcy(Slender)    =  DBy*MAX(Mmin_y, QMb_y+QMs_y)     =       38.93 kN-m.
              Mcz(Slender)    =  DBz*MAX(Mmin_z, QMb_z+QMs_z)     =       39.00 kN-m.

      ( ). Check total moment including 2nd-order effects.
           -. Moments due to 1st-order effects.
              Mcy-1st =        38.93 kN-m.
              Mcz-1st =        39.00 kN-m.
           -. Moments due to 2nd-order effects.
              Mcy-2nd = DBy*(QMb_y + QMs_y) =        38.93 kN-m.
              Mcz-2nd = DBz*(QMb_z + QMs_z) =        39.00 kN-m.
           -. Ratio of moment due to 2nd-order effects to moment due to 1st-order effects.
              Mcy-2nd / Mcy-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.
              Mcz-2nd / Mcz-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.

      ( ). Design forces/moments of column(brace).
           -. Axial Force (Compression)      Pu   =      150.04 kN.
           -. Combined Bending Moment        Mc   =       55.11 kN-m.
           -. Bending Moment about Local-y   Mcy =       38.93 kN-m.
           -. Bending Moment about Local-z   Mcz =       39.00 kN-m.
           -. Shear Force of Local-y         Vuy =       21.35 kN.
           -. Shear Force of Local-z         Vuz =       21.32 kN.

 ===============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC_COLUMN(RC-BRACE).
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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute design parameters.
           -. Ag     =              0.1600 m^2.
           -. Ast    =              0.0020 m^2.
           -. Rhot   = Ast/Ag =   0.012742
           -. esu    = fy/Es  =   0.002100
           -. beta1  =   0.8500  ( fc < 28 MPa.)

      ( ). Check the ratio of reinforcement.
           -. Rhomin =   0.010000
           -. Rhomax =   0.040000
           -. Rhot   =   0.012742
              Rhomin < Rhot < Rhomax  --->  O.K !

      ( ). Compute eccentricities of biaxially loaded column.
           -. Ecny   = ABS(Mcz/Pu)     =      0.2599 m.
           -. Ecnz   = ABS(Mcy/Pu)     =      0.2595 m.
           -. Eccn   = ABS(Mc/Pu)      =      0.3673 m.
           -. Rota   = ATAN(Ecny/Ecnz) =     45.0528 deg.
           -. Rotation of neutral axis =     45.0528 deg.

      ( ). Compute concentric axial load capacity.
           -. Po     = (0.85*fc)*(Ag-Ast) + fy*Ast    =     4615.74 kN.
           -. Maximum Axial Load    : Pomax = 0.75*Po =     3461.80 kN.
           -. Maximum Axial Tension : Pt    = -fy*Ast =     -856.26 kN.

     ----------------------------------------------------------------------------
       *. Analysis of balanced condition.
     ----------------------------------------------------------------------------

      ( ). Compute capacity of concrete stress block.
           -. cb     = (0.003/(0.003+esu))*d  =       0.299 m.
           -. ab     = beta1*cb               =       0.255 m.
           -. Acom                            =       0.065 m^2.
           -. DCcy                            =       0.080 m.
           -. DCcz                            =       0.080 m.
           -. Cc     = 0.85*fc*Acom           =     1542.24 kN.
           -. MnCy   = Cc*DCcz                =      123.21 kN-m.
           -. MnCz   = Cc*DCcy                =      123.55 kN-m.

      ( ). Compute capacity of reinforcement.
```

i	dsi	esi	fsi	Asi	Fsi	dzi	MnPyi	dyi	MnPzi
1	0.509	-0.002100	-420000.00	5.097e-04	-214.06	-0.160	34.25	-0.160	34.25
2	0.283	0.000165	32915.35	5.097e-04	16.78	0.160	2.68	-0.160	-2.68
3	0.057	0.002433	420000.00	5.097e-04	214.06	0.160	34.25	0.160	34.25
4	0.283	0.000169	33751.32	5.097e-04	17.20	-0.160	-2.75	0.160	2.75

```
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ----------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =       33.98 kN.
```

```
-. MnPy   = SUM [ MnPyi ]  =       68.43 kN-m.
-. MnPz   = SUM [ MnPzi ]  =       68.57 kN-m.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute nominal capacity(Pb,Mb) of Balanced Condition.
           -. Pb     = Cc + Ps                =     1576.22 kN.
           -. Mny    = MnCy + MnPy            =      191.64 kN-m.
           -. Mnz    = MnCz + MnPz            =      192.12 kN-m.
           -. Mb     = SQRT(Mny^2+Mnz^2)      =      271.36 kN-m.

      ( ). Compare actual eccentricity with balanced eccentricity.
           -. Balanced eccentricity : eb   = Mb/Pb        =    0.172 m.
           -. Minimum eccentricity  : Emin (not defined)  =    0.000 m.
           -. Actual eccentricity   : Eccn = Mu/Pu        =    0.367 m.
           -. eb   < Eccn       --->  Tension controls.

     ----------------------------------------------------------------------------
       *. Final analysis with searched neutral axis.
     ----------------------------------------------------------------------------

      ( ). Search for neutral axis......     Unit :  kN.,  m.
           -. P-M calculation method : Keep P constant
          -----------------------------------------------------
           Trial          c       Phi*Pn       Pu       Ratio
          -----------------------------------------------------
            1-st      0.180       181.10     150.040     82.85
            2-nd      0.173       105.59     150.040     57.90
            3-rd      0.176       143.53     150.040     95.47
            4-th      0.178       162.36     150.040     92.41
            5-th      0.177       152.96     150.040     98.09
            6-th      0.177       148.25     150.040     98.79
            7-th      0.177       150.60     150.040     99.63
          -----------------------------------------------------

      ( ). Compute capacity of compression stress block.
           -. a      = beta1*c                =       0.150 m.
           -. Acom                            =       0.023 m^2.
           -. DCcy                            =       0.129 m.
           -. DCcz                            =       0.129 m.
           -. Cc     = 0.85*fc*Acom           =      538.89 kN.
           -. MnCy   = Cc*DCcz                =       69.52 kN-m.
           -. MnCz   = Cc*DCcy                =       69.59 kN-m.

      ( ). Compute capacity of reinforcement.
      -----------------------------------------------------------------------------------------------
       i      dsi       esi        fsi         Asi         Fsi      dzi       MnPyi      dyi       MnPzi
      -----------------------------------------------------------------------------------------------
       1    0.509 -0.005628 -420000.00  5.097e-04    -214.06   -0.160       34.25   -0.160       34.25
       2    0.283 -0.001797 -359342.53  5.097e-04    -183.15    0.160      -29.30   -0.160       29.30
       3    0.057  0.002041  408272.92  5.097e-04     208.09    0.160       33.29    0.160       33.29
       4    0.283 -0.001790 -357928.31  5.097e-04    -182.43   -0.160       29.19    0.160      -29.19
      -----------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ---------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =     -371.55 kN.
```

```
-. MnPy   = SUM [ MnPyi ]  =       67.43 kN-m.
-. MnPz   = SUM [ MnPzi ]  =       67.66 kN-m.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute nominal capacity(Pn,Mn) of given neutral axis.
           -. Pn     = Cc + Ps                =      167.34 kN.
           -. Mny    = MnCy + MnPy            =      136.95 kN-m.
           -. Mnz    = MnCz + MnPz            =      137.25 kN-m.
           -. Mn     = SQRT(Mny^2+Mnz^2)      =      193.88 kN-m.

      ( ). Compute strength reduction factor.
           -. et       = 0.00563
           -. et_min  = 0.00210
           -. et_max  = 0.00500
           -. et > et_max  --->  phi =0.900

      ( ). Compute axial load and moment capacities(phiPn,phiMn).
           -. phiPn  = phi*Pn  =      150.60 kN.
           -. phiMn  = phi*Mn  =      174.50 kN-m.
           -. phiMny = phi*Mny =      123.25 kN-m.
           -. phiMnz = phi*Mnz =      123.52 kN-m.

      ( ). Check ratios of axial load and moment capacity.
           -. Rat_P  = Pu/phiPn = 0.996  <  1.000  --->  O.K.
           -. Rat_M  = Mc/phiMn = 0.316  <  1.000  --->  O.K.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   25,  POS = J )
           -. Applied axial force : Pu  =      136.21 kN.
           -. Applied shear force : Vuz =       21.32 kN.
           -. d      = Hc-do    =    0.360 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      137.41 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      103.06 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   28,  POS = J )
           -. Applied axial force : Pu  =      136.21 kN.
           -. Applied shear force : Vuy =       21.35 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.400 m.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                Gen 2022
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           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      137.41 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      103.06 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   25,  POS = 1/2 )
           -. Applied axial force : Pu  =      143.12 kN.
           -. Applied shear force : Vuz =       21.32 kN.
           -. d      = Hc-do    =    0.360 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      137.81 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      103.36 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   28,  POS = 1/2 )
           -. Applied axial force : Pu  =      143.12 kN.
           -. Applied shear force : Vuy =       21.35 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      137.81 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      103.36 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      *.midas Gen - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = COLUMN ,  MEMB =    12,  LCB =   20,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     1) : C40*40
        Section Type : Rectangular with Ties (RT)
        Section Height (HTc)            =         4.000 m.
        Section Depth  (Hc)             =         0.400 m.
        Section Width  (Bc)             =         0.400 m.
        Concrete Cover to C.O.R. (do)   =         0.040 m.
        Concrete Strength (fc)          =     28000.000 KPa.
        Modulus of Elasticity (Ec)      =  24870062.324 KPa.
        Main Rebar Strength (fy)        =    420000.000 KPa.
        Ties/Spirals Strength (fys)     =    420000.000 KPa.
        Modulus of Elasticity (Es)      = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

     *.REBAR PATTERN = RT -  4 -  2 - #8          Unit :  m.
        --------------------------------------------------------
           i          dyi          dzi      Rebar          Asi
        --------------------------------------------------------
           1       -0.160       -0.160      1-#8       0.00051
           2       -0.160        0.160      1-#8       0.00051
           3        0.160        0.160      1-#8       0.00051
           4        0.160       -0.160      1-#8       0.00051
        --------------------------------------------------------

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

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =   20
           ------------------------------------------------------------------------------
            Load Case             Pu          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                140.59         1.86        -3.08         1.90        -3.13
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL             140.59         1.86        -3.08         1.90        -3.13
            Others             99.64       -24.84       -45.73       -24.82       -45.76
           ------------------------------------------------------------------------------
            DL+LL+Others      240.23       -22.98       -48.81       -22.93       -48.89
           ------------------------------------------------------------------------------
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute member end moments(M1,M2).  Unit : kN-m.
           -. For Dead Load(DL).
              My1D =         1.86,   My2D =         3.08
              Mz1D =         1.90,   Mz2D =         3.13
           -. For Gravity Load(DL+LL).
              My1G =         1.86,   My2G =         3.08
              Mz1G =         1.90,   Mz2G =         3.13
           -. For Total Load(DL+LL+WL(EL)).
              My1  =        22.98,   My2  =        48.81
              Mz1  =        22.93,   Mz2  =        48.89

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. Slenderness ratio limits.
              SRy(Braced)   =  34 - 12*| My1/My2 | =   28.350  (Single curvature)
              SRz(Braced)   =  34 - 12*| Mz1/Mz2 | =   28.372  (Single curvature)
           -. Radii of gyration.
              ry     =  0.30*Hc  =    0.120 m.
              rz     =  0.30*Bc  =    0.120 m.
           -. Unbraced lengths.
              Ly     =    4.000 m.
              Lz     =    4.000 m.
           -. Effective length factors.
              Ky     =    1.000
              Kz     =    1.000
           -. SLENy  =  Ky*Ly/ry  =   33.333  >  SRy  --->  SLENDER.
           -. SLENz  =  Kz*Lz/rz  =   33.333  >  SRz  --->  SLENDER.

      ( ). Compute moment magnification factors for major axis(DBy,DSy).
           -. Ec       =  4700*SQRT[fc]                   =  2.4870e+07 KPa.
           -. Ryy      =  Bc*Hc^3/12                      =        0.0021 m^4.
           -. Rse                                         =    5.2273e-05 m^4.
           -. Betadnsy =  Pu_D/Pu                         =   0.5852
           -. EIy      =  (0.2*Ec*Ryy+Es*Rse)/(1+Betadnsy) =    13288.6134 (by N, mm).
           -. Pu       =  Pu_G + Pu_S            =       240.23 kN.
           -. Single Curvature Bending.
           -. Cmy      =         0.85 (Default or User defined value)
           -. Pcy      =  (pi^2*EIy)/(Ky*Ly)^2  =     8197.08 kN.
           -. DBy      =  Cmy/(1-Pu/(0.75*Pcy)) =        0.88
           -. DBy  <  1.0   --->  DBy  =  1.00
           -. DSy    =     1.00 (Default value)

      ( ). Compute moment magnification factors for minor axis(DBz,DSz).
           -. Ec       =  4700*SQRT[fc]                   =  2.4870e+07 KPa.
           -. Rzz      =  Hc*Bc^3/12                      =        0.0021 m^4.
           -. Rse                                         =    5.2273e-05 m^4.
           -. Betadnsz =  Pu_D/Pu                         =   0.5852
           -. EIz      =  (0.2*Ec*Rzz+Es*Rse)/(1+Betadnsz) =    13288.6134 (by N, mm).
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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          -. Pu       =  Pu_G + Pu_S           =      240.23 kN.
          -. Single Curvature Bending.
          -. Cmz      =        0.85 (Default or User defined value)
          -. Pcz      =  (pi^2*EIz)/(Kz*Lz)^2  =     8197.08 kN.
          -. DBz      =  Cmz/(1-Pu/(0.75*Pcz)) =        0.88
          -. DBz  <  1.0  --->  DBz  =  1.00
          -. DSz    =     1.00 (Default value)

     ( ). Compute minimum moments(Mmin).
          -. emin_y  =  15 mm. + 0.03*Hc    =       0.027 m.
          -. emin_z  =  15 mm. + 0.03*Bc    =       0.027 m.
          -. Mmin_y  =  Pu * emin_y         =        6.49 kN-m.
          -. Mmin_z  =  Pu * emin_z         =        6.49 kN-m.

     ( ). Compute magnified moments. (Pos : J, Local-y : Braced, Local-z : Braced).
          -. No sidesway moments.
             QMb_y  =  My_G   =       -3.08 kN-m.
             QMb_z  =  Mz_G   =       -3.13 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -45.73 kN-m.
             QMs_z  =  Mz_S   =      -45.76 kN-m.
          -. Compute magnified moments(Mcy,Mcz).
             Mcy(Slender)    =  DBy*MAX(Mmin_y, QMb_y+QMs_y)     =       48.81 kN-m.
             Mcz(Slender)    =  DBz*MAX(Mmin_z, QMb_z+QMs_z)     =       48.89 kN-m.

     ( ). Check total moment including 2nd-order effects.
          -. Moments due to 1st-order effects.
             Mcy-1st =        48.81 kN-m.
             Mcz-1st =        48.89 kN-m.
          -. Moments due to 2nd-order effects.
             Mcy-2nd = DBy*(QMb_y + QMs_y) =        48.81 kN-m.
             Mcz-2nd = DBz*(QMb_z + QMs_z) =        48.89 kN-m.
          -. Ratio of moment due to 2nd-order effects to moment due to 1st-order effects.
             Mcy-2nd / Mcy-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.
             Mcz-2nd / Mcz-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.

     ( ). Design forces/moments of column(brace).
          -. Axial Force (Compression)      Pu   =      240.23 kN.
          -. Combined Bending Moment        Mc   =       69.08 kN-m.
          -. Bending Moment about Local-y   Mcy =       48.81 kN-m.
          -. Bending Moment about Local-z   Mcz =       48.89 kN-m.
          -. Shear Force of Local-y         Vuy =       21.54 kN.
          -. Shear Force of Local-z         Vuz =       21.50 kN.

 ===============================================================================
   [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC_COLUMN(RC-BRACE).
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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute design parameters.
           -. Ag     =              0.1600 m^2.
           -. Ast    =              0.0020 m^2.
           -. Rhot   = Ast/Ag =   0.012742
           -. esu    = fy/Es  =   0.002100
           -. beta1  =   0.8500  ( fc < 28 MPa.)

      ( ). Check the ratio of reinforcement.
           -. Rhomin =   0.010000
           -. Rhomax =   0.040000
           -. Rhot   =   0.012742
              Rhomin < Rhot < Rhomax  --->  O.K !

      ( ). Compute eccentricities of biaxially loaded column.
           -. Ecny   = ABS(Mcz/Pu)     =      0.2035 m.
           -. Ecnz   = ABS(Mcy/Pu)     =      0.2032 m.
           -. Eccn   = ABS(Mc/Pu)      =      0.2876 m.
           -. Rota   = ATAN(Ecny/Ecnz) =     45.0504 deg.
           -. Rotation of neutral axis =     45.0504 deg.

      ( ). Compute concentric axial load capacity.
           -. Po     = (0.85*fc)*(Ag-Ast) + fy*Ast    =     4615.74 kN.
           -. Maximum Axial Load    : Pomax = 0.75*Po =     3461.80 kN.
           -. Maximum Axial Tension : Pt    = -fy*Ast =     -856.26 kN.

     ----------------------------------------------------------------------------
       *. Analysis of balanced condition.
     ----------------------------------------------------------------------------

      ( ). Compute capacity of concrete stress block.
           -. cb     = (0.003/(0.003+esu))*d  =       0.299 m.
           -. ab     = beta1*cb               =       0.255 m.
           -. Acom                            =       0.065 m^2.
           -. DCcy                            =       0.080 m.
           -. DCcz                            =       0.080 m.
           -. Cc     = 0.85*fc*Acom           =     1542.24 kN.
           -. MnCy   = Cc*DCcz                =      123.22 kN-m.
           -. MnCz   = Cc*DCcy                =      123.54 kN-m.

      ( ). Compute capacity of reinforcement.
```

i	dsi	esi	fsi	Asi	Fsi	dzi	MnPyi	dyi	MnPzi
1	0.509	-0.002100	-420000.00	5.097e-04	-214.06	-0.160	34.25	-0.160	34.25
2	0.283	0.000165	32934.25	5.097e-04	16.79	0.160	2.69	-0.160	-2.69
3	0.057	0.002433	420000.00	5.097e-04	214.06	0.160	34.25	0.160	34.25
4	0.283	0.000169	33732.41	5.097e-04	17.19	-0.160	-2.75	0.160	2.75

```
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ----------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =       33.98 kN.
```

```
-. MnPy   = SUM [ MnPyi ]  =       68.44 kN-m.
-. MnPz   = SUM [ MnPzi ]  =       68.57 kN-m.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute nominal capacity(Pb,Mb) of Balanced Condition.
           -. Pb     = Cc + Ps               =     1576.22 kN.
           -. Mny    = MnCy + MnPy           =      191.65 kN-m.
           -. Mnz    = MnCz + MnPz           =      192.11 kN-m.
           -. Mb     = SQRT(Mny^2+Mnz^2)     =      271.36 kN-m.

      ( ). Compare actual eccentricity with balanced eccentricity.
           -. Balanced eccentricity : eb   = Mb/Pb        =    0.172 m.
           -. Minimum eccentricity  : Emin (not defined)  =    0.000 m.
           -. Actual eccentricity   : Eccn = Mu/Pu        =    0.288 m.
           -. eb   < Eccn       --->  Tension controls.

     ----------------------------------------------------------------------------
       *. Final analysis with searched neutral axis.
     ----------------------------------------------------------------------------

      ( ). Search for neutral axis......     Unit :  kN.,  m.
           -. P-M calculation method : Keep P constant
          -----------------------------------------------------
           Trial          c       Phi*Pn       Pu       Ratio
          -----------------------------------------------------
            1-st      0.180       181.10     240.228     67.35
            2-nd      0.187       255.29     240.228     94.10
            3-rd      0.183       218.34     240.228     89.98
            4-th      0.185       236.85     240.228     98.57
            5-th      0.186       246.08     240.228     97.62
            6-th      0.185       241.47     240.228     99.49
            7-th      0.185       239.16     240.228     99.55
            8-th      0.185       240.31     240.228     99.96
          -----------------------------------------------------

      ( ). Compute capacity of compression stress block.
           -. a      = beta1*c               =       0.158 m.
           -. Acom                           =       0.025 m^2.
           -. DCcy                           =       0.126 m.
           -. DCcz                           =       0.126 m.
           -. Cc     = 0.85*fc*Acom          =      590.51 kN.
           -. MnCy   = Cc*DCcz               =       74.22 kN-m.
           -. MnCz   = Cc*DCcy               =       74.29 kN-m.

      ( ). Compute capacity of reinforcement.
      ------------------------------------------------------------------------------------------------
       i      dsi       esi         fsi         Asi          Fsi       dzi        MnPyi       dyi        MnPzi
      ------------------------------------------------------------------------------------------------
       1    0.509 -0.005242 -420000.00  5.097e-04    -214.06   -0.160       34.25    -0.160       34.25
       2    0.283 -0.001582 -316422.03  5.097e-04    -161.27    0.160      -25.80    -0.160       25.80
       3    0.057  0.002084  416844.58  5.097e-04     212.46    0.160       33.99     0.160       33.99
       4    0.283 -0.001576 -315132.15  5.097e-04    -160.62   -0.160       25.70     0.160      -25.70
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ------------------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ---------------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =     -323.50 kN.
           -. MnPy   = SUM [ MnPyi ]  =       68.14 kN-m.
           -. MnPz   = SUM [ MnPzi ]  =       68.35 kN-m.

      ( ). Compute nominal capacity(Pn,Mn) of given neutral axis.
           -. Pn     = Cc + Ps               =      267.01 kN.
           -. Mny    = MnCy + MnPy           =      142.35 kN-m.
           -. Mnz    = MnCz + MnPz           =      142.64 kN-m.
           -. Mn     = SQRT(Mny^2+Mnz^2)     =      201.52 kN-m.

      ( ). Compute strength reduction factor.
           -. et      = 0.00524
           -. et_min  = 0.00210
           -. et_max  = 0.00500
           -. et > et_max  --->  phi =0.900

      ( ). Compute axial load and moment capacities(phiPn,phiMn).
           -. phiPn  = phi*Pn  =      240.31 kN.
           -. phiMn  = phi*Mn  =      181.37 kN-m.
           -. phiMny = phi*Mny =      128.12 kN-m.
           -. phiMnz = phi*Mnz =      128.38 kN-m.

      ( ). Check ratios of axial load and moment capacity.
           -. Rat_P  = Pu/phiPn = 1.000  <  1.000  --->  O.K.
           -. Rat_M  = Mc/phiMn = 0.381  <  1.000  --->  O.K.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   18,  POS = J )
           -. Applied axial force : Pu  =      220.57 kN.
           -. Applied shear force : Vuz =       21.50 kN.
           -. d      = Hc-do    =    0.360 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      142.29 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      106.72 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   15,  POS = J )
           -. Applied axial force : Pu  =      220.57 kN.
           -. Applied shear force : Vuy =       21.54 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      142.29 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      106.72 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   18,  POS = 1/2 )
           -. Applied axial force : Pu  =      229.78 kN.
           -. Applied shear force : Vuz =       21.50 kN.
           -. d      = Hc-do    =    0.360 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      142.82 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      107.12 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   15,  POS = 1/2 )
           -. Applied axial force : Pu  =      229.79 kN.
           -. Applied shear force : Vuy =       21.54 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.400 m.
           -. Acv    = Bw*d     =    0.144 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      142.82 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      107.12 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      *.midas Gen - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = COLUMN ,  MEMB = 14310,  LCB =   26,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     4) : C40*50
        Section Type : Rectangular with Ties (RT)
        Section Height (HTc)            =        4.000 m.
        Section Depth  (Hc)             =        0.500 m.
        Section Width  (Bc)             =        0.400 m.
        Concrete Cover to C.O.R. (do)   =        0.040 m.
        Concrete Strength (fc)          =    28000.000 KPa.
        Modulus of Elasticity (Ec)      =  24870062.324 KPa.
        Main Rebar Strength (fy)        =   420000.000 KPa.
        Ties/Spirals Strength (fys)     =   420000.000 KPa.
        Modulus of Elasticity (Es)      = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

     *.REBAR PATTERN = RT -  4 -  2 - #8          Unit :  m.
        --------------------------------------------------------
           i          dyi          dzi      Rebar          Asi
        --------------------------------------------------------
           1       -0.160       -0.210      1-#8       0.00051
           2       -0.160        0.210      1-#8       0.00051
           3        0.160        0.210      1-#8       0.00051
           4        0.160       -0.210      1-#8       0.00051
        --------------------------------------------------------

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

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =   26
           -----------------------------------------------------------------------------
            Load Case              Pu          Myi          Myj          Mzi          Mzj
           -----------------------------------------------------------------------------
            DL                 204.48        -0.04         0.02    -9.01e-03         0.04
            LL                  -0.00         0.00         0.00         0.00         0.00
            DL+LL              204.48        -0.04         0.02    -9.01e-03         0.04
            Others              60.88        96.43        59.17        35.74         1.50
           -----------------------------------------------------------------------------
            DL+LL+Others       265.36        96.38        59.19        35.73         1.54
           -----------------------------------------------------------------------------
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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      ( ). Compute member end moments(M1,M2).  Unit : kN-m.
           -. For Dead Load(DL).
              My1D =         0.02,   My2D =         0.04
              Mz1D =     9.01e-03,   Mz2D =         0.04
           -. For Gravity Load(DL+LL).
              My1G =         0.02,   My2G =         0.04
              Mz1G =     9.01e-03,   Mz2G =         0.04
           -. For Total Load(DL+LL+WL(EL)).
              My1  =        59.19,   My2  =        96.38
              Mz1  =         1.54,   Mz2  =        35.73

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. Slenderness ratio limits.
              SRy(Braced)   =  34 - 12*| My1/My2 | =   26.631  (Single curvature)
              SRz(Braced)   =  34 - 12*| Mz1/Mz2 | =   33.483  (Single curvature)
           -. Radii of gyration.
              ry     =  0.30*Hc  =    0.150 m.
              rz     =  0.30*Bc  =    0.120 m.
           -. Unbraced lengths.
              Ly     =    4.000 m.
              Lz     =    4.000 m.
           -. Effective length factors.
              Ky     =    1.000
              Kz     =    1.000
           -. SLENy  =  Ky*Ly/ry  =   26.667  >  SRy  --->  SLENDER.
           -. SLENz  =  Kz*Lz/rz  =   33.333  <=  SRz  --->  NOT SLENDER.

      ( ). Compute moment magnification factors for major axis(DBy,DSy).
           -. Ec       =  4700*SQRT[fc]                    =  2.4870e+07 KPa.
           -. Ryy      =  Bc*Hc^3/12                       =        0.0042 m^4.
           -. Rse                                          =    8.9989e-05 m^4.
           -. Betadnsy =  Pu_D/Pu                          =   0.7706
           -. EIy      =  (0.2*Ec*Ryy+Es*Rse)/(1+Betadnsy) =    21870.3426 (by N, mm).
           -. Pu       =  Pu_G + Pu_S           =       265.36 kN.
           -. Single Curvature Bending.
           -. Cmy      =        0.85 (Default or User defined value)
           -. Pcy      =  (pi^2*EIy)/(Ky*Ly)^2  =    13490.73 kN.
           -. DBy      =  Cmy/(1-Pu/(0.75*Pcy)) =        0.87
           -. DBy  <  1.0  --->  DBy  =  1.00
           -. DSy    =     1.00 (Default value)

      ( ). Moment magnification factors for minor axis(DBz,DSz).
           -. DBz    =     1.00 (Default value)
           -. DSz    =     1.00 (Default value)

      ( ). Compute minimum moments(Mmin).
           -. emin_y  =  15 mm. + 0.03*Hc   =       0.030 m.
           -. emin_z  =  15 mm. + 0.03*Bc   =       0.027 m.
           -. Mmin_y  =  Pu * emin_y        =        7.96 kN-m.
           -. Mmin_z  =  Pu * emin_z        =        7.16 kN-m.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute magnified moments. (Pos : I, Local-y : Braced, Local-z : Braced).
           -. No sidesway moments.
              QMb_y  =  My_G   =       -0.04 kN-m.
              QMb_z  =  Mz_G   =   -9.01e-03 kN-m.
           -. Sidesway moments.
              QMs_y  =  My_S   =       96.43 kN-m.
              QMs_z  =  Mz_S   =       35.74 kN-m.
           -. Compute magnified moments(Mcy,Mcz).
              Mcy(Slender)    =  DBy*MAX(Mmin_y, QMb_y+QMs_y)     =       96.38 kN-m.
              Mcz(No-Slender) =  DBz*(QMb_z + QMs_z)              =       35.73 kN-m.

      ( ). Check total moment including 2nd-order effects.
           -. Moments due to 1st-order effects.
              Mcy-1st =       96.38 kN-m.
              Mcz-1st =       35.73 kN-m.
           -. Moments due to 2nd-order effects.
              Mcy-2nd = DBy*(QMb_y + QMs_y) =        96.38 kN-m.
              Mcz-2nd = DBz*(QMb_z + QMs_z) =        35.73 kN-m.
           -. Ratio of moment due to 2nd-order effects to moment due to 1st-order effects.
              Mcy-2nd / Mcy-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.
              Mcz-2nd / Mcz-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.

      ( ). Design forces/moments of column(brace).
           -. Axial Force (Compression)      Pu   =      265.36 kN.
           -. Combined Bending Moment        Mc   =      102.79 kN-m.
           -. Bending Moment about Local-y   Mcy =        96.38 kN-m.
           -. Bending Moment about Local-z   Mcz =        35.73 kN-m.
           -. Shear Force of Local-y         Vuy =         8.67 kN.
           -. Shear Force of Local-z         Vuz =        43.05 kN.

 ===============================================================================
   [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC_COLUMN(RC-BRACE).
 ===============================================================================

      ( ). Compute design parameters.
           -. Ag     =              0.2000 m^2.
           -. Ast    =              0.0020 m^2.
           -. Rhot   = Ast/Ag =   0.010194
           -. esu    = fy/Es  =   0.002100
           -. beta1  =   0.8500  ( fc < 28 MPa.)

      ( ). Check the ratio of reinforcement.
           -. Rhomin =   0.010000
           -. Rhomax =   0.040000
           -. Rhot   =   0.010194
              Rhomin < Rhot < Rhomax  --->  O.K !
```

PROJECT TITLE : Acueducto Agua Bonita San José del Guaviare

	Company	Leandro Castellanos	Client	
MIDAS	Author	Leandro Castellanos	File Name	Tanque Elevado.rcs

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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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      ( ). Compute eccentricities of biaxially loaded column.
           -. Ecny   = ABS(Mcz/Pu)     =      0.1346 m.
           -. Ecnz   = ABS(Mcy/Pu)     =      0.3632 m.
           -. Eccn   = ABS(Mc/Pu)      =      0.3874 m.
           -. Rota   = ATAN(Ecny/Ecnz) =     20.3395 deg.
           -. Rotation of neutral axis =     22.5164 deg.

      ( ). Compute concentric axial load capacity.
           -. Po     = (0.85*fc)*(Ag-Ast) + fy*Ast    =     5567.74 kN.
           -. Maximum Axial Load    : Pomax = 0.75*Po =     4175.80 kN.
           -. Maximum Axial Tension : Pt    = -fy*Ast =     -856.26 kN.

     ---------------------------------------------------------------------------
       *. Analysis of balanced condition.
     ---------------------------------------------------------------------------

      ( ). Compute capacity of concrete stress block.
           -. cb     = (0.003/(0.003+esu))*d  =       0.331 m.
           -. ab     = beta1*cb               =       0.281 m.
           -. Acom                            =       0.089 m^2.
           -. DCcy                            =       0.025 m.
           -. DCcz                            =       0.134 m.
           -. Cc     = 0.85*fc*Acom           =     2110.67 kN.
           -. MnCy   = Cc*DCcz                =      282.78 kN-m.
           -. MnCz   = Cc*DCcy                =       52.62 kN-m.

      ( ). Compute capacity of reinforcement.
      -----------------------------------------------------------------------------------------------
       i      dsi       esi         fsi        Asi         Fsi      dzi       MnPyi      dyi       MnPzi
      -----------------------------------------------------------------------------------------------
       1    0.563 -0.002100 -420000.00  5.097e-04    -214.06   -0.210       44.95   -0.160       34.25
       2    0.175  0.001416  283173.83  5.097e-04     144.33    0.210       30.31   -0.160      -23.09
       3    0.052  0.002526  420000.00  5.097e-04     214.06    0.210       44.95    0.160       34.25
       4    0.440 -0.000990 -197904.68  5.097e-04    -100.87   -0.210       21.18    0.160      -16.14
      -----------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      --------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =       43.46 kN.
           -. MnPy   = SUM [ MnPyi ]  =      141.40 kN-m.
           -. MnPz   = SUM [ MnPzi ]  =       29.27 kN-m.

      ( ). Compute nominal capacity(Pb,Mb) of Balanced Condition.
           -. Pb     = Cc + Ps               =     2154.13 kN.
           -. Mny    = MnCy + MnPy           =      424.18 kN-m.
           -. Mnz    = MnCz + MnPz           =       81.89 kN-m.
           -. Mb     = SQRT(Mny^2+Mnz^2)     =      432.01 kN-m.

      ( ). Compare actual eccentricity with balanced eccentricity.
           -. Balanced eccentricity : eb   = Mb/Pb         =    0.201 m.
           -. Minimum eccentricity  : Emin (not defined)   =    0.000 m.
           -. Actual eccentricity   : Eccn = Mu/Pu         =    0.387 m.
```

```
-. eb   < Eccn       --->  Tension controls.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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     ---------------------------------------------------------------------------
       *. Final analysis with searched neutral axis.
     ---------------------------------------------------------------------------

      ( ). Search for neutral axis......     Unit :  kN.,  m.
           -. P-M calculation method : Keep P constant
          -----------------------------------------------------
           Trial          c       Phi*Pn       Pu       Ratio
          -----------------------------------------------------
            1-st      0.167       402.90     265.359     65.86
            2-nd      0.159       325.33     265.359     81.57
            3-rd      0.155       286.88     265.359     92.50
            4-th      0.153       267.72     265.359     99.12
            5-th      0.152       258.16     265.359     97.21
            6-th      0.152       262.94     265.359     99.08
            7-th      0.153       265.33     265.359     99.99
            8-th      0.153       266.53     265.359     99.56
          -----------------------------------------------------

      ( ). Compute capacity of compression stress block.
           -. a      = beta1*c                =      0.130 m.
           -. Acom                            =      0.024 m^2.
           -. DCcy                            =      0.087 m.
           -. DCcz                            =      0.203 m.
           -. Cc     = 0.85*fc*Acom           =     567.22 kN.
           -. MnCy   = Cc*DCcz                =     115.23 kN-m.
           -. MnCz   = Cc*DCcy                =      49.33 kN-m.

      ( ). Compute capacity of reinforcement.
      ---------------------------------------------------------------------------------------------------
       i     dsi       esi         fsi         Asi         Fsi       dzi       MnPyi       dyi       MnPzi
      ---------------------------------------------------------------------------------------------------
      1    0.563 -0.008052 -420000.00  5.097e-04    -214.06   -0.210       44.95    -0.160       34.25
      2    0.175 -0.000433  -86576.14  5.097e-04     -44.13    0.210       -9.27    -0.160        7.06
      3    0.052  0.001974  394714.11  5.097e-04     201.18    0.210       42.25     0.160       32.19
      4    0.440 -0.005645 -420000.00  5.097e-04    -214.06   -0.210       44.95     0.160      -34.25
      ---------------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ----------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =     -271.08 kN.
           -. MnPy   = SUM [ MnPyi ]  =      122.89 kN-m.
           -. MnPz   = SUM [ MnPzi ]  =       39.25 kN-m.

      ( ). Compute nominal capacity(Pn,Mn) of given neutral axis.
           -. Pn     = Cc + Ps                =     296.14 kN.
           -. Mny    = MnCy + MnPy            =     238.11 kN-m.
           -. Mnz    = MnCz + MnPz            =      88.58 kN-m.
           -. Mn     = SQRT(Mny^2+Mnz^2)      =     254.06 kN-m.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute strength reduction factor.
           -. et       = 0.00805
           -. et_min   = 0.00210
           -. et_max   = 0.00500
           -. et > et_max  --->  phi =0.900

      ( ). Compute axial load and moment capacities(phiPn,phiMn).
           -. phiPn  = phi*Pn  =      266.53 kN.
           -. phiMn  = phi*Mn  =      228.65 kN-m.
           -. phiMny = phi*Mny =      214.30 kN-m.
           -. phiMnz = phi*Mnz =       79.72 kN-m.

      ( ). Check ratios of axial load and moment capacity.
           -. Rat_P  = Pu/phiPn = 0.996  <  1.000  --->  O.K.
           -. Rat_M  = Mc/phiMn = 0.450  <  1.000  --->  O.K.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   25,  POS = J )
           -. Applied axial force : Pu  =      248.08 kN.
           -. Applied shear force : Vuz =       43.05 kN.
           -. d      = Hc-do    =    0.460 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.184 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      180.18 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      135.14 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   32,  POS = J )
           -. Applied axial force : Pu  =      374.36 kN.
           -. Applied shear force : Vuy =        8.67 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.500 m.
           -. Acv    = Bw*d     =    0.180 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      183.57 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      137.68 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.
```

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--------------------------------------------------------------------------------------------
 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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 ================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN ( MIDDLE ).
 ================================================================================

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   25,  POS = 1/2 )
           -. Applied axial force : Pu  =      256.72 kN.
           -. Applied shear force : Vuz =       43.05 kN.
           -. d      = Hc-do    =    0.460 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.184 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      180.69 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      135.52 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   32,  POS = 1/2 )
           -. Applied axial force : Pu  =      383.00 kN.
           -. Applied shear force : Vuy =        8.67 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.500 m.
           -. Acv    = Bw*d     =    0.180 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      184.07 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      138.05 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.
      *.midas Gen - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = COLUMN ,  MEMB = 14312,  LCB =   28,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     4) : C40*50
        Section Type : Rectangular with Ties (RT)
        Section Height (HTc)             =        4.000 m.
        Section Depth  (Hc)              =        0.500 m.
        Section Width  (Bc)              =        0.400 m.
        Concrete Cover to C.O.R. (do)    =        0.040 m.
        Concrete Strength (fc)           =    28000.000 KPa.
        Modulus of Elasticity (Ec)       =  24870062.324 KPa.
        Main Rebar Strength (fy)         =   420000.000 KPa.
        Ties/Spirals Strength (fys)      =   420000.000 KPa.
        Modulus of Elasticity (Es)       = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

     *.REBAR PATTERN = RT -  4 -  2 - #8         Unit :  m.
        --------------------------------------------------------
           i          dyi           dzi      Rebar          Asi
        --------------------------------------------------------
           1       -0.160       -0.210      1-#8       0.00051
           2       -0.160        0.210      1-#8       0.00051
           3        0.160        0.210      1-#8       0.00051
           4        0.160       -0.210      1-#8       0.00051
        --------------------------------------------------------

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

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =   28
           -------------------------------------------------------------------------------
            Load Case              Pu          Myi          Myj          Mzi          Mzj
           -------------------------------------------------------------------------------
            DL                 162.89        -0.04         0.03         0.20         0.22
            LL                  -0.00         0.00         0.00         0.00         0.00
            DL+LL              162.89        -0.04         0.03         0.20         0.22
            Others              63.69        81.07        80.15         8.12        10.81
           -------------------------------------------------------------------------------
            DL+LL+Others       226.58        81.03        80.18         8.32        11.03
           -------------------------------------------------------------------------------

      ( ). Compute member end moments(M1,M2).  Unit : kN-m.
           -. For Dead Load(DL).
              My1D =         0.03,   My2D =         0.04
              Mz1D =         0.20,   Mz2D =         0.22
           -. For Gravity Load(DL+LL).
              My1G =         0.03,   My2G =         0.04
              Mz1G =         0.20,   Mz2G =         0.22
           -. For Total Load(DL+LL+WL(EL)).
              My1  =        80.18,   My2  =        81.03
              Mz1  =         8.32,   Mz2  =        11.03

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. Slenderness ratio limits.
              SRy(Braced)   =  34 - 12*| My1/My2 | =   22.127  (Single curvature)
              SRz(Braced)   =  34 - 12*| Mz1/Mz2 | =   24.949  (Single curvature)
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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           -. Radii of gyration.
              ry     =  0.30*Hc  =    0.150 m.
              rz     =  0.30*Bc  =    0.120 m.
           -. Unbraced lengths.
              Ly     =    4.000 m.
              Lz     =    4.000 m.
           -. Effective length factors.
              Ky     =    1.000
              Kz     =    1.000
           -. SLENy  =  Ky*Ly/ry  =   26.667  >  SRy  --->  SLENDER.
           -. SLENz  =  Kz*Lz/rz  =   33.333  >  SRz  --->  SLENDER.

      ( ). Compute moment magnification factors for major axis(DBy,DSy).
           -. Ec       =  4700*SQRT[fc]                    =  2.4870e+07 KPa.
           -. Ryy      =  Bc*Hc^3/12                       =        0.0042 m^4.
           -. Rse                                          =    8.9989e-05 m^4.
           -. Betadnsy =  Pu_D/Pu                          =   0.7189
           -. EIy      =  (0.2*Ec*Ryy+Es*Rse)/(1+Betadnsy) =    22527.6172 (by N, mm).
           -. Pu       =  Pu_G + Pu_S           =      226.58 kN.
           -. Single Curvature Bending.
           -. Cmy      =        0.85 (Default or User defined value)
           -. Pcy      =  (pi^2*EIy)/(Ky*Ly)^2  =    13896.17 kN.
           -. DBy      =  Cmy/(1-Pu/(0.75*Pcy)) =        0.87
           -. DBy  <  1.0  --->  DBy  =  1.00
           -. DSy    =     1.00 (Default value)

      ( ). Compute moment magnification factors for minor axis(DBz,DSz).
           -. Ec       =  4700*SQRT[fc]                    =  2.4870e+07 KPa.
           -. Rzz      =  Hc*Bc^3/12                       =        0.0027 m^4.
           -. Rse                                          =    5.2273e-05 m^4.
           -. Betadnsz =  Pu_D/Pu                          =   0.7189
           -. EIz      =  (0.2*Ec*Rzz+Es*Rse)/(1+Betadnsz) =    13798.6590 (by N, mm).
           -. Pu       =  Pu_G + Pu_S           =      226.58 kN.
           -. Single Curvature Bending.
           -. Cmz      =        0.85 (Default or User defined value)
           -. Pcz      =  (pi^2*EIz)/(Kz*Lz)^2  =     8511.71 kN.
           -. DBz      =  Cmz/(1-Pu/(0.75*Pcz)) =        0.88
           -. DBz  <  1.0  --->  DBz  =  1.00
           -. DSz    =     1.00 (Default value)

      ( ). Compute minimum moments(Mmin).
           -. emin_y  =  15 mm. + 0.03*Hc   =       0.030 m.
           -. emin_z  =  15 mm. + 0.03*Bc   =       0.027 m.
           -. Mmin_y  =  Pu * emin_y        =        6.80 kN-m.
           -. Mmin_z  =  Pu * emin_z        =        6.12 kN-m.
```

PROJECT TITLE : Acueducto Agua Bonita San José del Guaviare

MIDAS	**Company**	Leandro Castellanos	**Client**	
	Author	Leandro Castellanos	**File Name**	Tanque Elevado.rcs

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 midas Gen - RC-Column Design   [ NSR-10 ]                                   Gen 2022
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      ( ). Compute magnified moments. (Pos : J, Local-y : Braced, Local-z : Braced).
           -. No sidesway moments.
              QMb_y  =  My_G   =        0.03 kN-m.
              QMb_z  =  Mz_G   =        0.22 kN-m.
           -. Sidesway moments.
              QMs_y  =  My_S   =       80.15 kN-m.
              QMs_z  =  Mz_S   =       10.81 kN-m.
           -. Compute magnified moments(Mcy,Mcz).
              Mcy(Slender)    =  DBy*MAX(Mmin_y, QMb_y+QMs_y)     =       80.18 kN-m.
              Mcz(Slender)    =  DBz*MAX(Mmin_z, QMb_z+QMs_z)     =       11.03 kN-m.

      ( ). Check total moment including 2nd-order effects.
           -. Moments due to 1st-order effects.
              Mcy-1st =        80.18 kN-m.
              Mcz-1st =        11.03 kN-m.
           -. Moments due to 2nd-order effects.
              Mcy-2nd = DBy*(QMb_y + QMs_y) =        80.18 kN-m.
              Mcz-2nd = DBz*(QMb_z + QMs_z) =        11.03 kN-m.
           -. Ratio of moment due to 2nd-order effects to moment due to 1st-order effects.
              Mcy-2nd / Mcy-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.
              Mcz-2nd / Mcz-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.

      ( ). Design forces/moments of column(brace).
           -. Axial Force (Compression)      Pu  =      226.58 kN.
           -. Combined Bending Moment        Mc  =       80.93 kN-m.
           -. Bending Moment about Local-y   Mcy =       80.18 kN-m.
           -. Bending Moment about Local-z   Mcz =       11.03 kN-m.
           -. Shear Force of Local-y         Vuy =        4.15 kN.
           -. Shear Force of Local-z         Vuz =       44.43 kN.

 ===============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC_COLUMN(RC-BRACE).
 ===============================================================================

      ( ). Compute design parameters.
           -. Ag     =              0.2000 m^2.
           -. Ast    =              0.0020 m^2.
           -. Rhot   = Ast/Ag =   0.010194
           -. esu    = fy/Es  =   0.002100
           -. beta1  =   0.8500  ( fc < 28 MPa.)

      ( ). Check the ratio of reinforcement.
           -. Rhomin =   0.010000
           -. Rhomax =   0.040000
           -. Rhot   =   0.010194
              Rhomin < Rhot < Rhomax  --->  O.K !
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute eccentricities of biaxially loaded column.
           -. Ecny   = ABS(Mcz/Pu)     =      0.0487 m.
           -. Ecnz   = ABS(Mcy/Pu)     =      0.3539 m.
           -. Eccn   = ABS(Mc/Pu)      =      0.3572 m.
           -. Rota   = ATAN(Ecny/Ecnz) =      7.8343 deg.
           -. Rotation of neutral axis =      5.8757 deg.

      ( ). Compute concentric axial load capacity.
           -. Po     = (0.85*fc)*(Ag-Ast) + fy*Ast    =     5567.74 kN.
           -. Maximum Axial Load    : Pomax = 0.75*Po =     4175.80 kN.
           -. Maximum Axial Tension : Pt    = -fy*Ast =     -856.26 kN.

     ---------------------------------------------------------------------------
       *. Analysis of balanced condition.
     ---------------------------------------------------------------------------

      ( ). Compute capacity of concrete stress block.
           -. cb     = (0.003/(0.003+esu))*d  =       0.291 m.
           -. ab     = beta1*cb               =       0.247 m.
           -. Acom                            =       0.091 m^2.
           -. DCcy                            =       0.006 m.
           -. DCcz                            =       0.136 m.
           -. Cc     = 0.85*fc*Acom           =     2170.01 kN.
           -. MnCy   = Cc*DCcz                =      294.51 kN-m.
           -. MnCz   = Cc*DCcy                =       13.06 kN-m.

      ( ). Compute capacity of reinforcement.
```

i	dsi	esi	fsi	Asi	Fsi	dzi	MnPyi	dyi	MnPzi
1	0.494	-0.002100	-420000.00	5.097e-04	-214.06	-0.210	44.95	-0.160	34.25
2	0.077	0.002209	420000.00	5.097e-04	214.06	0.210	44.95	-0.160	-34.25
3	0.044	0.002547	420000.00	5.097e-04	214.06	0.210	44.95	0.160	34.25
4	0.462	-0.001762	-352420.46	5.097e-04	-179.62	-0.210	37.72	0.160	-28.74

```
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ----------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =       34.44 kN.
           -. MnPy   = SUM [ MnPyi ]  =      172.58 kN-m.
           -. MnPz   = SUM [ MnPzi ]  =        5.51 kN-m.

      ( ). Compute nominal capacity(Pb,Mb) of Balanced Condition.
           -. Pb     = Cc + Ps              =     2204.45 kN.
           -. Mny    = MnCy + MnPy          =      467.09 kN-m.
           -. Mnz    = MnCz + MnPz          =       18.57 kN-m.
           -. Mb     = SQRT(Mny^2+Mnz^2)    =      467.46 kN-m.

      ( ). Compare actual eccentricity with balanced eccentricity.
           -. Balanced eccentricity : eb   = Mb/Pb          =    0.212 m.
           -. Minimum eccentricity  : Emin (not defined)    =    0.000 m.
           -. Actual eccentricity   : Eccn = Mu/Pu          =    0.357 m.
```

```
-. eb   < Eccn       --->  Tension controls.
```

```
---------------------------------------------------------------------------------------
 midas Gen - RC-Column Design   [ NSR-10 ]                                    Gen 2022
=======================================================================================


     --------------------------------------------------------------------------
       *. Final analysis with searched neutral axis.
     --------------------------------------------------------------------------

      ( ). Search for neutral axis......     Unit :  kN.,  m.
           -. P-M calculation method : Keep P constant
          ----------------------------------------------------
           Trial          c       Phi*Pn       Pu       Ratio
          ----------------------------------------------------
            1-st      0.086       229.90     226.583     98.56
            2-nd      0.078       130.43     226.583     26.29
            3-rd      0.082       181.16     226.583     74.93
            4-th      0.084       205.76     226.583     89.88
            5-th      0.085       217.88     226.583     96.01
            6-th      0.085       223.90     226.583     98.80
            7-th      0.086       226.90     226.583     99.86
          ----------------------------------------------------

      ( ). Compute capacity of compression stress block.
           -. a      = beta1*c               =      0.073 m.
           -. Acom                           =      0.021 m^2.
           -. DCcy                           =      0.026 m.
           -. DCcz                           =      0.222 m.
           -. Cc     = 0.85*fc*Acom          =     499.67 kN.
           -. MnCy   = Cc*DCcz               =     111.13 kN-m.
           -. MnCz   = Cc*DCcy               =      13.06 kN-m.

      ( ). Compute capacity of reinforcement.
      ----------------------------------------------------------------------------------------------
       i      dsi       esi         fsi         Asi         Fsi      dzi       MnPyi      dyi       MnPzi
      ----------------------------------------------------------------------------------------------
       1    0.494 -0.014346 -420000.00  5.097e-04    -214.06   -0.210       44.95   -0.160       34.25
       2    0.077  0.000311   62221.53  5.097e-04      31.71    0.210        6.66   -0.160       -5.07
       3    0.044  0.001460  292077.05  5.097e-04     148.86    0.210       31.26    0.160       23.82
       4    0.462 -0.013197 -420000.00  5.097e-04    -214.06   -0.210       44.95    0.160      -34.25
      ----------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      -------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =     -247.55 kN.
           -. MnPy   = SUM [ MnPyi ]  =      127.83 kN-m.
           -. MnPz   = SUM [ MnPzi ]  =       18.74 kN-m.

      ( ). Compute nominal capacity(Pn,Mn) of given neutral axis.
           -. Pn     = Cc + Ps               =     252.12 kN.
           -. Mny    = MnCy + MnPy           =     238.96 kN-m.
           -. Mnz    = MnCz + MnPz           =      31.81 kN-m.
           -. Mn     = SQRT(Mny^2+Mnz^2)     =     241.07 kN-m.

      ( ). Compute strength reduction factor.
           -. et      = 0.01435
           -. et_min  = 0.00210
```

```
-. et_max  = 0.00500
-. et > et_max  --->  phi =0.900
```

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-----------------------------------------------------------------------------------------
 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute axial load and moment capacities(phiPn,phiMn).
           -. phiPn  = phi*Pn  =      226.90 kN.
           -. phiMn  = phi*Mn  =      216.96 kN-m.
           -. phiMny = phi*Mny =      215.06 kN-m.
           -. phiMnz = phi*Mnz =       28.63 kN-m.

      ( ). Check ratios of axial load and moment capacity.
           -. Rat_P  = Pu/phiPn = 0.999  <  1.000  --->  O.K.
           -. Rat_M  = Mc/phiMn = 0.373  <  1.000  --->  O.K.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   26,  POS = J )
           -. Applied axial force : Pu  =      226.58 kN.
           -. Applied shear force : Vuz =       44.43 kN.
           -. d      = Hc-do    =    0.460 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.184 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      178.91 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      134.18 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   31,  POS = J )
           -. Applied axial force : Pu  =      347.79 kN.
           -. Applied shear force : Vuy =        4.15 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.500 m.
           -. Acv    = Bw*d     =    0.180 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      182.03 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      136.52 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.
```

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------------------------------------------------------------------------------------------
 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   26,  POS = 1/2 )
           -. Applied axial force : Pu  =      235.22 kN.
           -. Applied shear force : Vuz =       44.43 kN.
           -. d      = Hc-do    =    0.460 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.184 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      179.42 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      134.57 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   31,  POS = 1/2 )
           -. Applied axial force : Pu  =      356.43 kN.
           -. Applied shear force : Vuy =        4.15 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.500 m.
           -. Acv    = Bw*d     =    0.180 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      182.53 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      136.90 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.
      *.midas Gen - RC-COLUMN  Analysis/Design Program.

      *.PROJECT        : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE    : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER         : Member Type = COLUMN ,  MEMB = 14314,  LCB =   25,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     4) : C40*50
        Section Type : Rectangular with Ties (RT)
        Section Height (HTc)             =         4.000 m.
        Section Depth  (Hc)              =         0.500 m.
        Section Width  (Bc)              =         0.400 m.
        Concrete Cover to C.O.R. (do)    =         0.040 m.
        Concrete Strength (fc)           =     28000.000 KPa.
        Modulus of Elasticity (Ec)       =  24870062.324 KPa.
        Main Rebar Strength (fy)         =    420000.000 KPa.
        Ties/Spirals Strength (fys)      =    420000.000 KPa.
        Modulus of Elasticity (Es)       = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

     *.REBAR PATTERN = RT -  4 -  2 - #8          Unit :  m.
        --------------------------------------------------------
           i          dyi          dzi      Rebar          Asi
        --------------------------------------------------------
           1       -0.160       -0.210      1-#8       0.00051
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                   Gen 2022
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          2       -0.160        0.210      1-#8       0.00051
          3        0.160        0.210      1-#8       0.00051
          4        0.160       -0.210      1-#8       0.00051
        --------------------------------------------------------

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

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =   25
           ------------------------------------------------------------------------------
            Load Case              Pu          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 139.36        -0.02         0.04         0.48        -2.91
            LL                  -0.00         0.00         0.00         0.00         0.00
            DL+LL              139.36        -0.02         0.04         0.48        -2.91
            Others              68.41        56.99        93.07         5.73        15.73
           ------------------------------------------------------------------------------
            DL+LL+Others       207.77        56.97        93.11         6.21        12.83
           ------------------------------------------------------------------------------

      ( ). Compute member end moments(M1,M2).  Unit : kN-m.
           -. For Dead Load(DL).
              My1D =         0.02,   My2D =         0.04
              Mz1D =         0.48,   Mz2D =         2.91
           -. For Gravity Load(DL+LL).
              My1G =         0.02,   My2G =         0.04
              Mz1G =         0.48,   Mz2G =         2.91
           -. For Total Load(DL+LL+WL(EL)).
              My1  =        56.97,   My2  =        93.11
              Mz1  =         6.21,   Mz2  =        12.83

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. Slenderness ratio limits.
              SRy(Braced)   =  34 - 12*| My1/My2 | =   26.658  (Single curvature)
              SRz(Braced)   =  34 - 12*| Mz1/Mz2 | =   28.192  (Single curvature)
           -. Radii of gyration.
              ry     =  0.30*Hc  =    0.150 m.
              rz     =  0.30*Bc  =    0.120 m.
           -. Unbraced lengths.
              Ly     =    4.000 m.
              Lz     =    4.000 m.
           -. Effective length factors.
              Ky     =    1.000
              Kz     =    1.000
           -. SLENy  =  Ky*Ly/ry  =   26.667  >  SRy  --->  SLENDER.
           -. SLENz  =  Kz*Lz/rz  =   33.333  >  SRz  --->  SLENDER.
```

PROJECT TITLE : Acueducto Agua Bonita San José del Guaviare

MIDAS	Company	Leandro Castellanos	Client	
	Author	Leandro Castellanos	File Name	Tanque Elevado.rcs

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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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      ( ). Compute moment magnification factors for major axis(DBy,DSy).
           -. Ec       =  4700*SQRT[fc]                      =  2.4870e+07 KPa.
           -. Ryy      =  Bc*Hc^3/12                         =        0.0042 m^4.
           -. Rse                                            =    8.9989e-05 m^4.
           -. Betadnsy =  Pu_D/Pu                            =   0.6707
           -. EIy      =  (0.2*Ec*Ryy+Es*Rse)/(1+Betadnsy) =    23177.1663 (by N, mm).
           -. Pu       =  Pu_G + Pu_S           =      207.77 kN.
           -. Single Curvature Bending.
           -. Cmy      =         0.85 (Default or User defined value)
           -. Pcy      =  (pi^2*EIy)/(Ky*Ly)^2  =    14296.84 kN.
           -. DBy      =  Cmy/(1-Pu/(0.75*Pcy)) =        0.87
           -. DBy  <  1.0  --->  DBy  =  1.00
           -. DSy    =     1.00 (Default value)

      ( ). Compute moment magnification factors for minor axis(DBz,DSz).
           -. Ec       =  4700*SQRT[fc]                      =  2.4870e+07 KPa.
           -. Rzz      =  Hc*Bc^3/12                         =        0.0027 m^4.
           -. Rse                                            =    5.2273e-05 m^4.
           -. Betadnsz =  Pu_D/Pu                            =   0.6707
           -. EIz      =  (0.2*Ec*Rzz+Es*Rse)/(1+Betadnsz) =    14196.5220 (by N, mm).
           -. Pu       =  Pu_G + Pu_S           =      207.77 kN.
           -. Single Curvature Bending.
           -. Cmz      =         0.85 (Default or User defined value)
           -. Pcz      =  (pi^2*EIz)/(Kz*Lz)^2  =     8757.13 kN.
           -. DBz      =  Cmz/(1-Pu/(0.75*Pcz)) =        0.88
           -. DBz  <  1.0  --->  DBz  =  1.00
           -. DSz    =     1.00 (Default value)

      ( ). Compute minimum moments(Mmin).
           -. emin_y  =  15 mm. + 0.03*Hc   =       0.030 m.
           -. emin_z  =  15 mm. + 0.03*Bc   =       0.027 m.
           -. Mmin_y  =  Pu * emin_y        =        6.23 kN-m.
           -. Mmin_z  =  Pu * emin_z        =        5.61 kN-m.

      ( ). Compute magnified moments. (Pos : J, Local-y : Braced, Local-z : Braced).
           -. No sidesway moments.
              QMb_y  =  My_G   =        0.04 kN-m.
              QMb_z  =  Mz_G   =       -2.91 kN-m.
           -. Sidesway moments.
              QMs_y  =  My_S   =       93.07 kN-m.
              QMs_z  =  Mz_S   =       15.73 kN-m.
           -. Compute magnified moments(Mcy,Mcz).
              Mcy(Slender)    =  DBy*MAX(Mmin_y, QMb_y+QMs_y)     =       93.11 kN-m.
              Mcz(Slender)    =  DBz*MAX(Mmin_z, QMb_z+QMs_z)     =       12.83 kN-m.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Check total moment including 2nd-order effects.
           -. Moments due to 1st-order effects.
              Mcy-1st =        93.11 kN-m.
              Mcz-1st =        12.83 kN-m.
           -. Moments due to 2nd-order effects.
              Mcy-2nd = DBy*(QMb_y + QMs_y) =        93.11 kN-m.
              Mcz-2nd = DBz*(QMb_z + QMs_z) =        12.83 kN-m.
           -. Ratio of moment due to 2nd-order effects to moment due to 1st-order effects.
              Mcy-2nd / Mcy-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.
              Mcz-2nd / Mcz-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.

      ( ). Design forces/moments of column(brace).
           -. Axial Force (Compression)      Pu  =      207.77 kN.
           -. Combined Bending Moment        Mc  =       93.99 kN-m.
           -. Bending Moment about Local-y   Mcy =       93.11 kN-m.
           -. Bending Moment about Local-z   Mcz =       12.83 kN-m.
           -. Shear Force of Local-y         Vuy =        9.14 kN.
           -. Shear Force of Local-z         Vuz =       41.55 kN.

 ===============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC_COLUMN(RC-BRACE).
 ===============================================================================

      ( ). Compute design parameters.
           -. Ag     =              0.2000 m^2.
           -. Ast    =              0.0020 m^2.
           -. Rhot   = Ast/Ag =   0.010194
           -. esu    = fy/Es  =   0.002100
           -. beta1  =   0.8500  ( fc < 28 MPa.)

      ( ). Check the ratio of reinforcement.
           -. Rhomin =   0.010000
           -. Rhomax =   0.040000
           -. Rhot   =   0.010194
              Rhomin < Rhot < Rhomax  --->  O.K !

      ( ). Compute eccentricities of biaxially loaded column.
           -. Ecny   = ABS(Mcz/Pu)     =      0.0617 m.
           -. Ecnz   = ABS(Mcy/Pu)     =      0.4481 m.
           -. Eccn   = ABS(Mc/Pu)      =      0.4524 m.
           -. Rota   = ATAN(Ecny/Ecnz) =      7.8432 deg.
           -. Rotation of neutral axis =      5.8824 deg.

      ( ). Compute concentric axial load capacity.
           -. Po     = (0.85*fc)*(Ag-Ast) + fy*Ast    =     5567.74 kN.
           -. Maximum Axial Load    : Pomax = 0.75*Po =     4175.80 kN.
           -. Maximum Axial Tension : Pt    = -fy*Ast =     -856.26 kN.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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     ---------------------------------------------------------------------------
       *. Analysis of balanced condition.
     ---------------------------------------------------------------------------

      ( ). Compute capacity of concrete stress block.
           -. cb     = (0.003/(0.003+esu))*d  =       0.291 m.
           -. ab     = beta1*cb               =       0.247 m.
           -. Acom                            =       0.091 m^2.
           -. DCcy                            =       0.006 m.
           -. DCcz                            =       0.136 m.
           -. Cc     = 0.85*fc*Acom           =     2169.98 kN.
           -. MnCy   = Cc*DCcz                =      294.51 kN-m.
           -. MnCz   = Cc*DCcy                =       13.08 kN-m.

      ( ). Compute capacity of reinforcement.
      ----------------------------------------------------------------------------------------------
       i      dsi      esi        fsi        Asi         Fsi      dzi        MnPyi      dyi       MnPzi
      ----------------------------------------------------------------------------------------------
       1    0.494 -0.002100 -420000.00  5.097e-04    -214.06   -0.210       44.95   -0.160       34.25
       2    0.077  0.002209  420000.00  5.097e-04     214.06    0.210       44.95   -0.160      -34.25
       3    0.044  0.002547  420000.00  5.097e-04     214.06    0.210       44.95    0.160       34.25
       4    0.462 -0.001762 -352348.59  5.097e-04    -179.58   -0.210       37.71    0.160      -28.73
      ----------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ----------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =       34.48 kN.
           -. MnPy   = SUM [ MnPyi ]  =      172.57 kN-m.
           -. MnPz   = SUM [ MnPzi ]  =        5.52 kN-m.

      ( ). Compute nominal capacity(Pb,Mb) of Balanced Condition.
           -. Pb     = Cc + Ps               =     2204.46 kN.
           -. Mny    = MnCy + MnPy           =      467.08 kN-m.
           -. Mnz    = MnCz + MnPz           =       18.59 kN-m.
           -. Mb     = SQRT(Mny^2+Mnz^2)     =      467.45 kN-m.

      ( ). Compare actual eccentricity with balanced eccentricity.
           -. Balanced eccentricity : eb   = Mb/Pb        =    0.212 m.
           -. Minimum eccentricity  : Emin (not defined)  =    0.000 m.
           -. Actual eccentricity   : Eccn = Mu/Pu        =    0.452 m.
           -. eb   < Eccn       --->  Tension controls.

     ---------------------------------------------------------------------------
       *. Final analysis with searched neutral axis.
     ---------------------------------------------------------------------------

      ( ). Search for neutral axis......     Unit :  kN.,  m.
           -. P-M calculation method : Keep P constant
         ---------------------------------------------------
          Trial          c        Phi*Pn       Pu       Ratio
         ---------------------------------------------------
            1-st      0.086       229.63     207.769     90.48
```

2-nd	0.078	130.15	207.769	40.36
3-rd	0.082	180.89	207.769	85.14

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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            4-th      0.084       205.49     207.769     98.89
            5-th      0.085       217.62     207.769     95.47
            6-th      0.084       211.57     207.769     98.20
            7-th      0.084       208.53     207.769     99.63
          -----------------------------------------------------

      ( ). Compute capacity of compression stress block.
           -. a      = beta1*c              =       0.071 m.
           -. Acom                          =       0.020 m^2.
           -. DCcy                          =       0.027 m.
           -. DCcz                          =       0.223 m.
           -. Cc     = 0.85*fc*Acom         =      487.17 kN.
           -. MnCy   = Cc*DCcz              =      108.65 kN-m.
           -. MnCz   = Cc*DCcy              =       13.08 kN-m.

      ( ). Compute capacity of reinforcement.
      ----------------------------------------------------------------------------------------------
      i      dsi       esi          fsi         Asi         Fsi      dzi        MnPyi      dyi       MnPzi
      ----------------------------------------------------------------------------------------------
      1    0.494 -0.014660 -420000.00  5.097e-04    -214.06   -0.210        44.95   -0.160       34.25
      2    0.077  0.000261   52258.91  5.097e-04      26.64    0.210         5.59   -0.160       -4.26
      3    0.044  0.001433  286512.22  5.097e-04     146.03    0.210        30.67    0.160       23.36
      4    0.462 -0.013488 -420000.00  5.097e-04    -214.06   -0.210        44.95    0.160      -34.25
      ----------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ---------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =     -255.46 kN.
           -. MnPy   = SUM [ MnPyi ]  =      126.17 kN-m.
           -. MnPz   = SUM [ MnPzi ]  =       19.10 kN-m.

      ( ). Compute nominal capacity(Pn,Mn) of given neutral axis.
           -. Pn     = Cc + Ps              =      231.70 kN.
           -. Mny    = MnCy + MnPy          =      234.82 kN-m.
           -. Mnz    = MnCz + MnPz          =       32.18 kN-m.
           -. Mn     = SQRT(Mny^2+Mnz^2)    =      237.01 kN-m.

      ( ). Compute strength reduction factor.
           -. et      = 0.01466
           -. et_min  = 0.00210
           -. et_max  = 0.00500
           -. et > et_max  --->  phi =0.900

      ( ). Compute axial load and moment capacities(phiPn,phiMn).
           -. phiPn  = phi*Pn  =      208.53 kN.
           -. phiMn  = phi*Mn  =      213.31 kN-m.
           -. phiMny = phi*Mny =      211.34 kN-m.
           -. phiMnz = phi*Mnz =       28.96 kN-m.

      ( ). Check ratios of axial load and moment capacity.
           -. Rat_P  = Pu/phiPn = 0.996  <  1.000  --->  O.K.
           -. Rat_M  = Mc/phiMn = 0.441  <  1.000  --->  O.K.
```

PROJECT TITLE : Acueducto Agua Bonita San José del Guaviare

MIDAS	Company	Leandro Castellanos	Client	
	Author	Leandro Castellanos	File Name	Tanque Elevado.rcs

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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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 ===============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN ( END ).
 ===============================================================================

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   28,  POS = J )
           -. Applied axial force : Pu  =      207.77 kN.
           -. Applied shear force : Vuz =       41.55 kN.
           -. d      = Hc-do    =    0.460 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.184 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      177.80 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      133.35 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   18,  POS = J )
           -. Applied axial force : Pu  =      254.22 kN.
           -. Applied shear force : Vuy =        9.14 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.500 m.
           -. Acv    = Bw*d     =    0.180 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      176.62 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      132.47 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   28,  POS = 1/2 )
           -. Applied axial force : Pu  =      216.41 kN.
           -. Applied shear force : Vuz =       41.55 kN.
           -. d      = Hc-do    =    0.460 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.184 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      178.31 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      133.73 kN.
```

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--------------------------------------------------------------------------------------------
 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   18,  POS = 1/2 )
           -. Applied axial force : Pu  =      265.74 kN.
           -. Applied shear force : Vuy =        9.14 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.500 m.
           -. Acv    = Bw*d     =    0.180 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      177.29 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      132.97 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.
      *.midas Gen - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = COLUMN ,  MEMB = 14316,  LCB =   28,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     4) : C40*50
        Section Type : Rectangular with Ties (RT)
        Section Height (HTc)             =        4.000 m.
        Section Depth  (Hc)              =        0.500 m.
        Section Width  (Bc)              =        0.400 m.
        Concrete Cover to C.O.R. (do)    =        0.040 m.
        Concrete Strength (fc)           =    28000.000 KPa.
        Modulus of Elasticity (Ec)       =  24870062.324 KPa.
        Main Rebar Strength (fy)         =   420000.000 KPa.
        Ties/Spirals Strength (fys)      =   420000.000 KPa.
        Modulus of Elasticity (Es)       = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

     *.REBAR PATTERN = RT -  4 -  2 - #8          Unit :  m.
        --------------------------------------------------------
           i          dyi          dzi      Rebar          Asi
        --------------------------------------------------------
           1       -0.160       -0.210      1-#8       0.00051
           2       -0.160        0.210      1-#8       0.00051
           3        0.160        0.210      1-#8       0.00051
           4        0.160       -0.210      1-#8       0.00051
        --------------------------------------------------------

 ===============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
============================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =   28
           -------------------------------------------------------------------------------
            Load Case              Pu           Myi           Myj           Mzi           Mzj
           -------------------------------------------------------------------------------
            DL                 201.44          0.04         -0.05          0.02         -0.03
            LL                  -0.00          0.00          0.00          0.00          0.00
            DL+LL              201.44          0.04         -0.05          0.02         -0.03
            Others              61.62         96.39         59.02         36.05          0.84
           -------------------------------------------------------------------------------
            DL+LL+Others       263.06         96.43         58.98         36.06          0.81
           -------------------------------------------------------------------------------

      ( ). Compute member end moments(M1,M2).  Unit : kN-m.
           -. For Dead Load(DL).
              My1D =          0.04,   My2D =          0.05
              Mz1D =          0.02,   Mz2D =          0.03
           -. For Gravity Load(DL+LL).
              My1G =          0.04,   My2G =          0.05
              Mz1G =          0.02,   Mz2G =          0.03
           -. For Total Load(DL+LL+WL(EL)).
              My1  =         58.98,   My2  =         96.43
              Mz1  =          0.81,   Mz2  =         36.06

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. Slenderness ratio limits.
              SRy(Braced)   =  34 - 12*| My1/My2 | =   26.661  (Single curvature)
              SRz(Braced)   =  34 - 12*| Mz1/Mz2 | =   33.732  (Single curvature)
           -. Radii of gyration.
              ry     =  0.30*Hc  =    0.150 m.
              rz     =  0.30*Bc  =    0.120 m.
           -. Unbraced lengths.
              Ly     =    4.000 m.
              Lz     =    4.000 m.
           -. Effective length factors.
              Ky     =    1.000
              Kz     =    1.000
           -. SLENy  =  Ky*Ly/ry  =   26.667  >  SRy  --->  SLENDER.
           -. SLENz  =  Kz*Lz/rz  =   33.333  <=  SRz  --->  NOT SLENDER.

      ( ). Compute moment magnification factors for major axis(DBy,DSy).
           -. Ec       =  4700*SQRT[fc]                   =  2.4870e+07 KPa.
           -. Ryy      =  Bc*Hc^3/12                      =        0.0042 m^4.
           -. Rse                                         =    8.9989e-05 m^4.
           -. Betadnsy =  Pu_D/Pu                         =   0.7657
           -. EIy      =  (0.2*Ec*Ryy+Es*Rse)/(1+Betadnsy) =    21929.9591 (by N, mm).
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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           -. Pu       =  Pu_G + Pu_S           =      263.06 kN.
           -. Single Curvature Bending.
           -. Cmy      =         0.85 (Default or User defined value)
           -. Pcy      =  (pi^2*EIy)/(Ky*Ly)^2  =    13527.50 kN.
           -. DBy      =  Cmy/(1-Pu/(0.75*Pcy)) =        0.87
           -. DBy  <  1.0  --->  DBy  =  1.00
           -. DSy    =     1.00 (Default value)

      ( ). Moment magnification factors for minor axis(DBz,DSz).
           -. DBz    =     1.00 (Default value)
           -. DSz    =     1.00 (Default value)

      ( ). Compute minimum moments(Mmin).
           -. emin_y  =  15 mm. + 0.03*Hc   =       0.030 m.
           -. emin_z  =  15 mm. + 0.03*Bc   =       0.027 m.
           -. Mmin_y  =  Pu * emin_y        =        7.89 kN-m.
           -. Mmin_z  =  Pu * emin_z        =        7.10 kN-m.

      ( ). Compute magnified moments. (Pos : I, Local-y : Braced, Local-z : Braced).
           -. No sidesway moments.
              QMb_y  =  My_G   =        0.04 kN-m.
              QMb_z  =  Mz_G   =        0.02 kN-m.
           -. Sidesway moments.
              QMs_y  =  My_S   =       96.39 kN-m.
              QMs_z  =  Mz_S   =       36.05 kN-m.
           -. Compute magnified moments(Mcy,Mcz).
              Mcy(Slender)    =  DBy*MAX(Mmin_y, QMb_y+QMs_y)     =       96.43 kN-m.
              Mcz(No-Slender) =  DBz*(QMb_z + QMs_z)              =       36.06 kN-m.

      ( ). Check total moment including 2nd-order effects.
           -. Moments due to 1st-order effects.
              Mcy-1st =        96.43 kN-m.
              Mcz-1st =        36.06 kN-m.
           -. Moments due to 2nd-order effects.
              Mcy-2nd = DBy*(QMb_y + QMs_y) =        96.43 kN-m.
              Mcz-2nd = DBz*(QMb_z + QMs_z) =        36.06 kN-m.
           -. Ratio of moment due to 2nd-order effects to moment due to 1st-order effects.
              Mcy-2nd / Mcy-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.
              Mcz-2nd / Mcz-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.

      ( ). Design forces/moments of column(brace).
           -. Axial Force (Compression)      Pu  =      263.06 kN.
           -. Combined Bending Moment        Mc  =      102.96 kN-m.
           -. Bending Moment about Local-y   Mcy =       96.43 kN-m.
           -. Bending Moment about Local-z   Mcz =       36.06 kN-m.
           -. Shear Force of Local-y         Vuy =        8.67 kN.
           -. Shear Force of Local-z         Vuz =       43.08 kN.

 ===============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC_COLUMN(RC-BRACE).
 ===============================================================================
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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      ( ). Compute design parameters.
           -. Ag     =               0.2000 m^2.
           -. Ast    =               0.0020 m^2.
           -. Rhot   = Ast/Ag =   0.010194
           -. esu    = fy/Es  =   0.002100
           -. beta1  =   0.8500  ( fc < 28 MPa.)

      ( ). Check the ratio of reinforcement.
           -. Rhomin =   0.010000
           -. Rhomax =   0.040000
           -. Rhot   =   0.010194
              Rhomin < Rhot < Rhomax  --->  O.K !

      ( ). Compute eccentricities of biaxially loaded column.
           -. Ecny   = ABS(Mcz/Pu)     =      0.1371 m.
           -. Ecnz   = ABS(Mcy/Pu)     =      0.3666 m.
           -. Eccn   = ABS(Mc/Pu)      =      0.3914 m.
           -. Rota   = ATAN(Ecny/Ecnz) =     20.5052 deg.
           -. Rotation of neutral axis =     22.6769 deg.

      ( ). Compute concentric axial load capacity.
           -. Po     = (0.85*fc)*(Ag-Ast) + fy*Ast    =     5567.74 kN.
           -. Maximum Axial Load    : Pomax = 0.75*Po =     4175.80 kN.
           -. Maximum Axial Tension : Pt    = -fy*Ast =     -856.26 kN.

     ----------------------------------------------------------------------------
       *. Analysis of balanced condition.
     ----------------------------------------------------------------------------

      ( ). Compute capacity of concrete stress block.
           -. cb     = (0.003/(0.003+esu))*d  =       0.331 m.
           -. ab     = beta1*cb               =       0.282 m.
           -. Acom                            =       0.089 m^2.
           -. DCcy                            =       0.025 m.
           -. DCcz                            =       0.134 m.
           -. Cc     = 0.85*fc*Acom           =     2110.04 kN.
           -. MnCy   = Cc*DCcz                =      282.59 kN-m.
           -. MnCz   = Cc*DCcy                =       53.04 kN-m.

      ( ). Compute capacity of reinforcement.
```

i	dsi	esi	fsi	Asi	Fsi	dzi	MnPyi	dyi	MnPzi
1	0.563	-0.002100	-420000.00	5.097e-04	-214.06	-0.210	44.95	-0.160	34.25
2	0.176	0.001409	281810.64	5.097e-04	143.63	0.210	30.16	-0.160	-22.98
3	0.052	0.002526	420000.00	5.097e-04	214.06	0.210	44.95	0.160	34.25
4	0.440	-0.000983	-196577.56	5.097e-04	-100.19	-0.210	21.04	0.160	-16.03

```
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ----------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =       43.44 kN.
```

```
-. MnPy   = SUM [ MnPyi ]  =      141.11 kN-m.
-. MnPz   = SUM [ MnPzi ]  =       29.49 kN-m.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute nominal capacity(Pb,Mb) of Balanced Condition.
           -. Pb     = Cc + Ps                =     2153.49 kN.
           -. Mny    = MnCy + MnPy            =      423.70 kN-m.
           -. Mnz    = MnCz + MnPz            =       82.53 kN-m.
           -. Mb     = SQRT(Mny^2+Mnz^2)      =      431.66 kN-m.

      ( ). Compare actual eccentricity with balanced eccentricity.
           -. Balanced eccentricity : eb   = Mb/Pb        =    0.200 m.
           -. Minimum eccentricity  : Emin (not defined)  =    0.000 m.
           -. Actual eccentricity   : Eccn = Mu/Pu        =    0.391 m.
           -. eb   < Eccn       --->  Tension controls.

     ----------------------------------------------------------------------------
       *. Final analysis with searched neutral axis.
     ----------------------------------------------------------------------------

      ( ). Search for neutral axis......     Unit :  kN.,  m.
           -. P-M calculation method : Keep P constant
          -----------------------------------------------------
           Trial          c       Phi*Pn       Pu       Ratio
          -----------------------------------------------------
            1-st      0.167       399.18     263.060     65.90
            2-nd      0.159       321.78     263.060     81.75
            3-rd      0.155       283.40     263.060     92.82
            4-th      0.153       264.28     263.060     99.54
          -----------------------------------------------------

      ( ). Compute capacity of compression stress block.
           -. a      = beta1*c                =       0.130 m.
           -. Acom                            =       0.024 m^2.
           -. DCcy                            =       0.088 m.
           -. DCcz                            =       0.203 m.
           -. Cc     = 0.85*fc*Acom           =      565.89 kN.
           -. MnCy   = Cc*DCcz                =      114.88 kN-m.
           -. MnCz   = Cc*DCcy                =       49.54 kN-m.

      ( ). Compute capacity of reinforcement.
      ------------------------------------------------------------------------------------------------
       i      dsi       esi         fsi         Asi         Fsi      dzi       MnPyi      dyi       MnPzi
      ------------------------------------------------------------------------------------------------
       1    0.563 -0.008043 -420000.00  5.097e-04    -214.06   -0.210       44.95   -0.160       34.25
       2    0.176 -0.000445  -88954.00  5.097e-04     -45.34    0.210       -9.52   -0.160        7.25
       3    0.052  0.001974  394807.58  5.097e-04     201.22    0.210       42.26    0.160       32.20
       4    0.440 -0.005624 -420000.00  5.097e-04    -214.06   -0.210       44.95    0.160      -34.25
      ------------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ---------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]     =     -272.24 kN.
           -. MnPy   = SUM [ MnPyi ]   =      122.64 kN-m.
           -. MnPz   = SUM [ MnPzi ]   =       39.45 kN-m.
```

PROJECT TITLE : Acueducto Agua Bonita San José del Guaviare

	Company	Leandro Castellanos	Client	
	Author	Leandro Castellanos	File Name	Tanque Elevado.rcs

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute nominal capacity(Pn,Mn) of given neutral axis.
           -. Pn     = Cc + Ps               =      293.65 kN.
           -. Mny    = MnCy + MnPy           =      237.53 kN-m.
           -. Mnz    = MnCz + MnPz           =       88.99 kN-m.
           -. Mn     = SQRT(Mny^2+Mnz^2)     =      253.65 kN-m.

      ( ). Compute strength reduction factor.
           -. et       = 0.00804
           -. et_min  = 0.00210
           -. et_max  = 0.00500
           -. et > et_max  --->  phi =0.900

      ( ). Compute axial load and moment capacities(phiPn,phiMn).
           -. phiPn  = phi*Pn  =      264.28 kN.
           -. phiMn  = phi*Mn  =      228.28 kN-m.
           -. phiMny = phi*Mny =      213.77 kN-m.
           -. phiMnz = phi*Mnz =       80.09 kN-m.

      ( ). Check ratios of axial load and moment capacity.
           -. Rat_P  = Pu/phiPn = 0.995  <  1.000  --->  O.K.
           -. Rat_M  = Mc/phiMn = 0.451  <  1.000  --->  O.K.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   28,  POS = J )
           -. Applied axial force : Pu  =      245.78 kN.
           -. Applied shear force : Vuz =       43.08 kN.
           -. d      = Hc-do    =    0.460 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.184 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      180.05 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      135.04 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   28,  POS = J )
           -. Applied axial force : Pu  =      245.78 kN.
           -. Applied shear force : Vuy =        8.67 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.500 m.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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           -. Acv    = Bw*d     =    0.180 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      176.13 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      132.10 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   28,  POS = 1/2 )
           -. Applied axial force : Pu  =      254.42 kN.
           -. Applied shear force : Vuz =       43.08 kN.
           -. d      = Hc-do    =    0.460 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.184 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      180.56 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      135.42 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   28,  POS = 1/2 )
           -. Applied axial force : Pu  =      254.42 kN.
           -. Applied shear force : Vuy =        8.67 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.500 m.
           -. Acv    = Bw*d     =    0.180 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      176.63 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      132.47 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      *.midas Gen - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = COLUMN ,  MEMB = 14318,  LCB =   26,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     4) : C40*50
        Section Type : Rectangular with Ties (RT)
        Section Height (HTc)            =        4.000 m.
        Section Depth  (Hc)             =        0.500 m.
        Section Width  (Bc)             =        0.400 m.
        Concrete Cover to C.O.R. (do)   =        0.040 m.
        Concrete Strength (fc)          =    28000.000 KPa.
        Modulus of Elasticity (Ec)      =  24870062.324 KPa.
        Main Rebar Strength (fy)        =   420000.000 KPa.
        Ties/Spirals Strength (fys)     =   420000.000 KPa.
        Modulus of Elasticity (Es)      = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

     *.REBAR PATTERN = RT -  4 -  2 - #8          Unit :  m.
        --------------------------------------------------------
           i          dyi          dzi      Rebar          Asi
        --------------------------------------------------------
           1       -0.160       -0.210      1-#8       0.00051
           2       -0.160        0.210      1-#8       0.00051
           3        0.160        0.210      1-#8       0.00051
           4        0.160       -0.210      1-#8       0.00051
        --------------------------------------------------------

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

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =   26
           ------------------------------------------------------------------------------
            Load Case             Pu           Myi           Myj           Mzi           Mzj
           ------------------------------------------------------------------------------
            DL                159.80         -0.01          0.05         -0.19         -0.19
            LL                 -0.00          0.00          0.00          0.00          0.00
            DL+LL             159.80         -0.01          0.05         -0.19         -0.19
            Others             64.42         81.08         80.21          7.21          9.12
           ------------------------------------------------------------------------------
            DL+LL+Others      224.22         81.06         80.26          7.01          8.92
           ------------------------------------------------------------------------------
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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      ( ). Compute member end moments(M1,M2).  Unit : kN-m.
           -. For Dead Load(DL).
              My1D =         0.01,   My2D =         0.05
              Mz1D =         0.19,   Mz2D =         0.19
           -. For Gravity Load(DL+LL).
              My1G =         0.01,   My2G =         0.05
              Mz1G =         0.19,   Mz2G =         0.19
           -. For Total Load(DL+LL+WL(EL)).
              My1  =        80.26,   My2  =        81.06
              Mz1  =         7.01,   Mz2  =         8.92

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. Slenderness ratio limits.
              SRy(Braced)   =  34 - 12*| My1/My2 | =   22.119  (Single curvature)
              SRz(Braced)   =  34 + 12*MIN(|Mz1/Mz2|,0.5) =   40.000  (Reverse curvature)
           -. Radii of gyration.
              ry     =  0.30*Hc  =    0.150 m.
              rz     =  0.30*Bc  =    0.120 m.
           -. Unbraced lengths.
              Ly     =    4.000 m.
              Lz     =    4.000 m.
           -. Effective length factors.
              Ky     =    1.000
              Kz     =    1.000
           -. SLENy  =  Ky*Ly/ry  =   26.667  >  SRy  --->  SLENDER.
           -. SLENz  =  Kz*Lz/rz  =   33.333  <=  SRz  --->  NOT SLENDER.

      ( ). Compute moment magnification factors for major axis(DBy,DSy).
           -. Ec       =  4700*SQRT[fc]                   =  2.4870e+07 KPa.
           -. Ryy      =  Bc*Hc^3/12                      =        0.0042 m^4.
           -. Rse                                         =    8.9989e-05 m^4.
           -. Betadnsy =  Pu_D/Pu                         =   0.7127
           -. EIy      =  (0.2*Ec*Ryy+Es*Rse)/(1+Betadnsy) =    22609.1213 (by N, mm).
           -. Pu       =  Pu_G + Pu_S            =       224.22 kN.
           -. Single Curvature Bending.
           -. Cmy      =        0.85 (Default or User defined value)
           -. Pcy      =  (pi^2*EIy)/(Ky*Ly)^2  =    13946.44 kN.
           -. DBy      =  Cmy/(1-Pu/(0.75*Pcy)) =        0.87
           -. DBy  <  1.0  --->  DBy  =  1.00
           -. DSy    =     1.00 (Default value)

      ( ). Moment magnification factors for minor axis(DBz,DSz).
           -. DBz    =     1.00 (Default value)
           -. DSz    =     1.00 (Default value)

      ( ). Compute minimum moments(Mmin).
           -. emin_y  =  15 mm. + 0.03*Hc   =       0.030 m.
           -. emin_z  =  15 mm. + 0.03*Bc   =       0.027 m.
           -. Mmin_y  =  Pu * emin_y        =        6.73 kN-m.
           -. Mmin_z  =  Pu * emin_z        =        6.05 kN-m.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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      ( ). Compute magnified moments. (Pos : J, Local-y : Braced, Local-z : Braced).
           -. No sidesway moments.
              QMb_y  =  My_G   =        0.05 kN-m.
              QMb_z  =  Mz_G   =       -0.19 kN-m.
           -. Sidesway moments.
              QMs_y  =  My_S   =       80.21 kN-m.
              QMs_z  =  Mz_S   =        9.12 kN-m.
           -. Compute magnified moments(Mcy,Mcz).
              Mcy(Slender)    =  DBy*MAX(Mmin_y, QMb_y+QMs_y)     =       80.26 kN-m.
              Mcz(No-Slender) =  DBz*(QMb_z + QMs_z)              =        8.92 kN-m.

      ( ). Check total moment including 2nd-order effects.
           -. Moments due to 1st-order effects.
              Mcy-1st =       80.26 kN-m.
              Mcz-1st =        8.92 kN-m.
           -. Moments due to 2nd-order effects.
              Mcy-2nd = DBy*(QMb_y + QMs_y) =        80.26 kN-m.
              Mcz-2nd = DBz*(QMb_z + QMs_z) =         8.92 kN-m.
           -. Ratio of moment due to 2nd-order effects to moment due to 1st-order effects.
              Mcy-2nd / Mcy-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.
              Mcz-2nd / Mcz-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.

      ( ). Design forces/moments of column(brace).
           -. Axial Force (Compression)      Pu  =      224.22 kN.
           -. Combined Bending Moment        Mc  =       80.75 kN-m.
           -. Bending Moment about Local-y   Mcy =       80.26 kN-m.
           -. Bending Moment about Local-z   Mcz =        8.92 kN-m.
           -. Shear Force of Local-y         Vuy =        4.14 kN.
           -. Shear Force of Local-z         Vuz =       44.44 kN.

 ===============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC_COLUMN(RC-BRACE).
 ===============================================================================

      ( ). Compute design parameters.
           -. Ag     =              0.2000 m^2.
           -. Ast    =              0.0020 m^2.
           -. Rhot   = Ast/Ag =   0.010194
           -. esu    = fy/Es  =   0.002100
           -. beta1  =   0.8500  ( fc < 28 MPa.)

      ( ). Check the ratio of reinforcement.
           -. Rhomin =   0.010000
           -. Rhomax =   0.040000
           -. Rhot   =   0.010194
              Rhomin < Rhot < Rhomax  --->  O.K !
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute eccentricities of biaxially loaded column.
           -. Ecny   = ABS(Mcz/Pu)     =      0.0398 m.
           -. Ecnz   = ABS(Mcy/Pu)     =      0.3579 m.
           -. Eccn   = ABS(Mc/Pu)      =      0.3602 m.
           -. Rota   = ATAN(Ecny/Ecnz) =      6.3446 deg.
           -. Rotation of neutral axis =      4.7585 deg.

      ( ). Compute concentric axial load capacity.
           -. Po     = (0.85*fc)*(Ag-Ast) + fy*Ast    =     5567.74 kN.
           -. Maximum Axial Load    : Pomax = 0.75*Po =     4175.80 kN.
           -. Maximum Axial Tension : Pt    = -fy*Ast =     -856.26 kN.

     ----------------------------------------------------------------------------
       *. Analysis of balanced condition.
     ----------------------------------------------------------------------------

      ( ). Compute capacity of concrete stress block.
           -. cb     = (0.003/(0.003+esu))*d  =       0.287 m.
           -. ab     = beta1*cb               =       0.244 m.
           -. Acom                            =       0.091 m^2.
           -. DCcy                            =       0.005 m.
           -. DCcz                            =       0.136 m.
           -. Cc     = 0.85*fc*Acom           =     2173.75 kN.
           -. MnCy   = Cc*DCcz                =      294.83 kN-m.
           -. MnCz   = Cc*DCcy                =       10.57 kN-m.

      ( ). Compute capacity of reinforcement.
      ------------------------------------------------------------------------------------------------
       i      dsi       esi        fsi        Asi         Fsi      dzi       MnPyi      dyi       MnPzi
      ------------------------------------------------------------------------------------------------
       1    0.488 -0.002100 -420000.00  5.097e-04    -214.06   -0.210       44.95   -0.160       34.25
       2    0.070  0.002272  420000.00  5.097e-04     214.06    0.210       44.95   -0.160      -34.25
       3    0.043  0.002549  420000.00  5.097e-04     214.06    0.210       44.95    0.160       34.25
       4    0.462 -0.001823 -364546.61  5.097e-04    -185.80   -0.210       39.02    0.160      -29.73
      ------------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ----------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =       28.26 kN.
           -. MnPy   = SUM [ MnPyi ]  =      173.88 kN-m.
           -. MnPz   = SUM [ MnPzi ]  =        4.52 kN-m.

      ( ). Compute nominal capacity(Pb,Mb) of Balanced Condition.
           -. Pb     = Cc + Ps               =     2202.01 kN.
           -. Mny    = MnCy + MnPy           =      468.70 kN-m.
           -. Mnz    = MnCz + MnPz           =       15.09 kN-m.
           -. Mb     = SQRT(Mny^2+Mnz^2)     =      468.95 kN-m.

      ( ). Compare actual eccentricity with balanced eccentricity.
           -. Balanced eccentricity : eb   = Mb/Pb        =    0.213 m.
           -. Minimum eccentricity  : Emin (not defined)  =    0.000 m.
           -. Actual eccentricity   : Eccn = Mu/Pu        =    0.360 m.
```

```
-. eb   < Eccn       --->  Tension controls.
```

```
-----------------------------------------------------------------------------------------
 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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     ---------------------------------------------------------------------------
       *. Final analysis with searched neutral axis.
     ---------------------------------------------------------------------------

      ( ). Search for neutral axis......     Unit :  kN.,  m.
           -. P-M calculation method : Keep P constant
          -----------------------------------------------------
           Trial          c       Phi*Pn       Pu       Ratio
          -----------------------------------------------------
            1-st      0.085       274.55     224.218     81.67
            2-nd      0.077       178.00     224.218     74.03
            3-rd      0.081       227.22     224.218     98.68
            4-th      0.079       202.86     224.218     89.47
            5-th      0.080       215.10     224.218     95.76
            6-th      0.080       221.17     224.218     98.62
            7-th      0.080       224.20     224.218     99.99
            8-th      0.081       225.71     224.218     99.34
            9-th      0.081       224.95     224.218     99.67
          -----------------------------------------------------

      ( ). Compute capacity of compression stress block.
           -. a      = beta1*c                =       0.068 m.
           -. Acom                            =       0.021 m^2.
           -. DCcy                            =       0.021 m.
           -. DCcz                            =       0.223 m.
           -. Cc     = 0.85*fc*Acom           =      495.29 kN.
           -. MnCy   = Cc*DCcz                =      110.50 kN-m.
           -. MnCz   = Cc*DCcy                =       10.57 kN-m.

      ( ). Compute capacity of reinforcement.
      ----------------------------------------------------------------------------------------------
      i      dsi       esi          fsi         Asi          Fsi      dzi        MnPyi      dyi       MnPzi
      ----------------------------------------------------------------------------------------------
      1    0.488 -0.015193 -420000.00  5.097e-04    -214.06   -0.210        44.95   -0.160       34.25
      2    0.070  0.000402   80403.64  5.097e-04      40.98    0.210         8.61   -0.160       -6.56
      3    0.043  0.001391  278221.74  5.097e-04     141.80    0.210        29.78    0.160       22.69
      4    0.462 -0.014204 -420000.00  5.097e-04    -214.06   -0.210        44.95    0.160      -34.25
      ----------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =     -245.35 kN.
           -. MnPy   = SUM [ MnPyi ]  =      128.29 kN-m.
           -. MnPz   = SUM [ MnPzi ]  =       16.13 kN-m.

      ( ). Compute nominal capacity(Pn,Mn) of given neutral axis.
           -. Pn     = Cc + Ps                =      249.95 kN.
           -. Mny    = MnCy + MnPy            =      238.79 kN-m.
           -. Mnz    = MnCz + MnPz            =       26.70 kN-m.
           -. Mn     = SQRT(Mny^2+Mnz^2)      =      240.28 kN-m.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                   Gen 2022
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      ( ). Compute strength reduction factor.
           -. et       = 0.01519
           -. et_min   = 0.00210
           -. et_max   = 0.00500
           -. et > et_max  --->  phi =0.900

      ( ). Compute axial load and moment capacities(phiPn,phiMn).
           -. phiPn  = phi*Pn  =      224.95 kN.
           -. phiMn  = phi*Mn  =      216.25 kN-m.
           -. phiMny = phi*Mny =      214.91 kN-m.
           -. phiMnz = phi*Mnz =       24.03 kN-m.

      ( ). Check ratios of axial load and moment capacity.
           -. Rat_P  = Pu/phiPn = 0.997  <  1.000  --->  O.K.
           -. Rat_M  = Mc/phiMn = 0.373  <  1.000  --->  O.K.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   28,  POS = J )
           -. Applied axial force : Pu  =      224.22 kN.
           -. Applied shear force : Vuz =       44.44 kN.
           -. d      = Hc-do    =    0.460 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.184 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      178.77 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      134.08 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   27,  POS = J )
           -. Applied axial force : Pu  =      224.22 kN.
           -. Applied shear force : Vuy =        4.14 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.500 m.
           -. Acv    = Bw*d     =    0.180 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      174.89 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      131.16 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.
```

```
-----------------------------------------------------------------------------------------
 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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 ===============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN ( MIDDLE ).
 ===============================================================================

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   28,  POS = 1/2 )
           -. Applied axial force : Pu  =      232.86 kN.
           -. Applied shear force : Vuz =       44.44 kN.
           -. d      = Hc-do    =    0.460 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.184 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      179.28 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      134.46 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   27,  POS = 1/2 )
           -. Applied axial force : Pu  =      232.86 kN.
           -. Applied shear force : Vuy =        4.14 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.500 m.
           -. Acv    = Bw*d     =    0.180 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      175.39 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      131.54 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.
      *.midas Gen - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = COLUMN ,  MEMB = 14320,  LCB =   28,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     4) : C40*50
        Section Type : Rectangular with Ties (RT)
        Section Height (HTc)           =        4.000 m.
        Section Depth  (Hc)            =        0.500 m.
        Section Width  (Bc)            =        0.400 m.
        Concrete Cover to C.O.R. (do)  =        0.040 m.
        Concrete Strength (fc)         =    28000.000 KPa.
        Modulus of Elasticity (Ec)     =  24870062.324 KPa.
        Main Rebar Strength (fy)       =   420000.000 KPa.
        Ties/Spirals Strength (fys)    =   420000.000 KPa.
        Modulus of Elasticity (Es)     = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

     *.REBAR PATTERN = RT -  4 -  2 - #8         Unit :  m.
        --------------------------------------------------------
           i          dyi          dzi      Rebar          Asi
        --------------------------------------------------------
           1       -0.160       -0.210      1-#8       0.00051
           2       -0.160        0.210      1-#8       0.00051
           3        0.160        0.210      1-#8       0.00051
           4        0.160       -0.210      1-#8       0.00051
        --------------------------------------------------------

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

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =   28
           ------------------------------------------------------------------------------
            Load Case              Pu           Myi           Myj           Mzi           Mzj
           ------------------------------------------------------------------------------
            DL                 136.17          0.10         -0.52         -0.45          2.98
            LL                  -0.00          0.00          0.00          0.00          0.00
            DL+LL              136.17          0.10         -0.52         -0.45          2.98
            Others              69.12         56.92         91.76          2.80         34.81
           ------------------------------------------------------------------------------
            DL+LL+Others       205.29         57.02         91.24          2.35         37.79
           ------------------------------------------------------------------------------

      ( ). Compute member end moments(M1,M2).  Unit : kN-m.
           -. For Dead Load(DL).
              My1D =         0.10,   My2D =         0.52
              Mz1D =         0.45,   Mz2D =         2.98
           -. For Gravity Load(DL+LL).
              My1G =         0.10,   My2G =         0.52
              Mz1G =         0.45,   Mz2G =         2.98
           -. For Total Load(DL+LL+WL(EL)).
              My1  =        57.02,   My2  =        91.24
              Mz1  =         2.35,   Mz2  =        37.79

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. Slenderness ratio limits.
              SRy(Braced)   =  34 - 12*| My1/My2 | =   26.500  (Single curvature)
              SRz(Braced)   =  34 - 12*| Mz1/Mz2 | =   33.254  (Single curvature)
```

	Company	Leandro Castellanos	Client	
	Author	Leandro Castellanos	File Name	Tanque Elevado.rcs

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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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           -. Radii of gyration.
              ry     =  0.30*Hc  =    0.150 m.
              rz     =  0.30*Bc  =    0.120 m.
           -. Unbraced lengths.
              Ly     =    4.000 m.
              Lz     =    4.000 m.
           -. Effective length factors.
              Ky     =    1.000
              Kz     =    1.000
           -. SLENy  =  Ky*Ly/ry  =   26.667  >  SRy  --->  SLENDER.
           -. SLENz  =  Kz*Lz/rz  =   33.333  >  SRz  --->  SLENDER.

      ( ). Compute moment magnification factors for major axis(DBy,DSy).
           -. Ec       =  4700*SQRT[fc]                    =  2.4870e+07 KPa.
           -. Ryy      =  Bc*Hc^3/12                       =        0.0042 m^4.
           -. Rse                                          =    8.9989e-05 m^4.
           -. Betadnsy =  Pu_D/Pu                          =   0.6633
           -. EIy      =  (0.2*Ec*Ryy+Es*Rse)/(1+Betadnsy) =    23280.7874 (by N, mm).
           -. Pu       =  Pu_G + Pu_S           =      205.29 kN.
           -. Single Curvature Bending.
           -. Cmy      =        0.85 (Default or User defined value)
           -. Pcy      =  (pi^2*EIy)/(Ky*Ly)^2  =    14360.76 kN.
           -. DBy      =  Cmy/(1-Pu/(0.75*Pcy)) =        0.87
           -. DBy  <  1.0  --->  DBy  =  1.00
           -. DSy    =     1.00 (Default value)

      ( ). Compute moment magnification factors for minor axis(DBz,DSz).
           -. Ec       =  4700*SQRT[fc]                    =  2.4870e+07 KPa.
           -. Rzz      =  Hc*Bc^3/12                       =        0.0027 m^4.
           -. Rse                                          =    5.2273e-05 m^4.
           -. Betadnsz =  Pu_D/Pu                          =   0.6633
           -. EIz      =  (0.2*Ec*Rzz+Es*Rse)/(1+Betadnsz) =    14259.9922 (by N, mm).
           -. Pu       =  Pu_G + Pu_S           =      205.29 kN.
           -. Single Curvature Bending.
           -. Cmz      =        0.85 (Default or User defined value)
           -. Pcz      =  (pi^2*EIz)/(Kz*Lz)^2  =     8796.28 kN.
           -. DBz      =  Cmz/(1-Pu/(0.75*Pcz)) =        0.88
           -. DBz  <  1.0  --->  DBz  =  1.00
           -. DSz    =     1.00 (Default value)

      ( ). Compute minimum moments(Mmin).
           -. emin_y  =  15 mm. + 0.03*Hc   =       0.030 m.
           -. emin_z  =  15 mm. + 0.03*Bc   =       0.027 m.
           -. Mmin_y  =  Pu * emin_y        =        6.16 kN-m.
           -. Mmin_z  =  Pu * emin_z        =        5.54 kN-m.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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      ( ). Compute magnified moments. (Pos : J, Local-y : Braced, Local-z : Braced).
           -. No sidesway moments.
              QMb_y  =  My_G   =       -0.52 kN-m.
              QMb_z  =  Mz_G   =        2.98 kN-m.
           -. Sidesway moments.
              QMs_y  =  My_S   =       91.76 kN-m.
              QMs_z  =  Mz_S   =       34.81 kN-m.
           -. Compute magnified moments(Mcy,Mcz).
              Mcy(Slender)    =  DBy*MAX(Mmin_y, QMb_y+QMs_y)     =       91.24 kN-m.
              Mcz(Slender)    =  DBz*MAX(Mmin_z, QMb_z+QMs_z)     =       37.79 kN-m.

      ( ). Check total moment including 2nd-order effects.
           -. Moments due to 1st-order effects.
              Mcy-1st =        91.24 kN-m.
              Mcz-1st =        37.79 kN-m.
           -. Moments due to 2nd-order effects.
              Mcy-2nd = DBy*(QMb_y + QMs_y) =        91.24 kN-m.
              Mcz-2nd = DBz*(QMb_z + QMs_z) =        37.79 kN-m.
           -. Ratio of moment due to 2nd-order effects to moment due to 1st-order effects.
              Mcy-2nd / Mcy-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.
              Mcz-2nd / Mcz-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.

      ( ). Design forces/moments of column(brace).
           -. Axial Force (Compression)      Pu   =      205.29 kN.
           -. Combined Bending Moment        Mc   =       98.76 kN-m.
           -. Bending Moment about Local-y   Mcy =        91.24 kN-m.
           -. Bending Moment about Local-z   Mcz =        37.79 kN-m.
           -. Shear Force of Local-y         Vuy =         8.99 kN.
           -. Shear Force of Local-z         Vuz =        41.65 kN.

 ===============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC_COLUMN(RC-BRACE).
 ===============================================================================

      ( ). Compute design parameters.
           -. Ag     =               0.2000 m^2.
           -. Ast    =               0.0020 m^2.
           -. Rhot   = Ast/Ag =    0.010194
           -. esu    = fy/Es  =    0.002100
           -. beta1  =   0.8500  ( fc < 28 MPa.)

      ( ). Check the ratio of reinforcement.
           -. Rhomin =   0.010000
           -. Rhomax =   0.040000
           -. Rhot   =   0.010194
              Rhomin < Rhot < Rhomax  --->  O.K !
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute eccentricities of biaxially loaded column.
           -. Ecny   = ABS(Mcz/Pu)     =      0.1841 m.
           -. Ecnz   = ABS(Mcy/Pu)     =      0.4445 m.
           -. Eccn   = ABS(Mc/Pu)      =      0.4811 m.
           -. Rota   = ATAN(Ecny/Ecnz) =     22.4986 deg.
           -. Rotation of neutral axis =     22.4986 deg.

      ( ). Compute concentric axial load capacity.
           -. Po     = (0.85*fc)*(Ag-Ast) + fy*Ast    =     5567.74 kN.
           -. Maximum Axial Load    : Pomax = 0.75*Po =     4175.80 kN.
           -. Maximum Axial Tension : Pt    = -fy*Ast =     -856.26 kN.

     ----------------------------------------------------------------------------
       *. Analysis of balanced condition.
     ----------------------------------------------------------------------------

      ( ). Compute capacity of concrete stress block.
           -. cb     = (0.003/(0.003+esu))*d  =       0.331 m.
           -. ab     = beta1*cb               =       0.281 m.
           -. Acom                            =       0.089 m^2.
           -. DCcy                            =       0.025 m.
           -. DCcz                            =       0.134 m.
           -. Cc     = 0.85*fc*Acom           =     2110.74 kN.
           -. MnCy   = Cc*DCcz                =      282.80 kN-m.
           -. MnCz   = Cc*DCcy                =       52.57 kN-m.

      ( ). Compute capacity of reinforcement.
      ------------------------------------------------------------------------------------------------
       i      dsi       esi         fsi        Asi         Fsi      dzi       MnPyi      dyi       MnPzi
      ------------------------------------------------------------------------------------------------
       1    0.563 -0.002100 -420000.00  5.097e-04    -214.06   -0.210       44.95   -0.160       34.25
       2    0.175  0.001417  283325.14  5.097e-04     144.40    0.210       30.32   -0.160      -23.10
       3    0.052  0.002526  420000.00  5.097e-04     214.06    0.210       44.95    0.160       34.25
       4    0.440 -0.000990 -198051.99  5.097e-04    -100.94   -0.210       21.20    0.160      -16.15
      ------------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ---------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =       43.46 kN.
           -. MnPy   = SUM [ MnPyi ]  =      141.43 kN-m.
           -. MnPz   = SUM [ MnPzi ]  =       29.25 kN-m.

      ( ). Compute nominal capacity(Pb,Mb) of Balanced Condition.
           -. Pb     = Cc + Ps               =     2154.20 kN.
           -. Mny    = MnCy + MnPy           =      424.23 kN-m.
           -. Mnz    = MnCz + MnPz           =       81.82 kN-m.
           -. Mb     = SQRT(Mny^2+Mnz^2)     =      432.05 kN-m.

      ( ). Compare actual eccentricity with balanced eccentricity.
           -. Balanced eccentricity : eb   = Mb/Pb          =    0.201 m.
           -. Minimum eccentricity  : Emin (not defined)    =    0.000 m.
           -. Actual eccentricity   : Eccn = Mu/Pu          =    0.481 m.
```

```
-. eb   < Eccn       --->  Tension controls.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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     ---------------------------------------------------------------------------
       *. Final analysis with searched neutral axis.
     ---------------------------------------------------------------------------

      ( ). Search for neutral axis......     Unit :  kN.,  m.
           -. P-M calculation method : Keep P constant
          -----------------------------------------------------
           Trial          c       Phi*Pn       Pu       Ratio
          -----------------------------------------------------
            1-st      0.133        86.62     205.289    -37.01
            2-nd      0.142       167.79     205.289     77.65
            3-rd      0.146       208.35     205.289     98.53
            4-th      0.144       188.07     205.289     90.84
            5-th      0.145       198.21     205.289     96.43
            6-th      0.146       203.28     205.289     99.01
            7-th      0.146       205.81     205.289     99.75
          -----------------------------------------------------

      ( ). Compute capacity of compression stress block.
           -. a      = beta1*c               =       0.124 m.
           -. Acom                           =       0.022 m^2.
           -. DCcy                           =       0.092 m.
           -. DCcz                           =       0.205 m.
           -. Cc     = 0.85*fc*Acom          =      519.91 kN.
           -. MnCy   = Cc*DCcz               =      106.67 kN-m.
           -. MnCz   = Cc*DCcy               =       47.70 kN-m.

      ( ). Compute capacity of reinforcement.
      ------------------------------------------------------------------------------------------------
       i      dsi       esi         fsi        Asi         Fsi      dzi       MnPyi      dyi       MnPzi
      ------------------------------------------------------------------------------------------------
       1    0.563 -0.008546 -420000.00  5.097e-04    -214.06   -0.210       44.95   -0.160       34.25
       2    0.175 -0.000585 -116947.73  5.097e-04     -59.61    0.210      -12.52   -0.160        9.54
       3    0.052  0.001928  385539.66  5.097e-04     196.50    0.210       41.27    0.160       31.44
       4    0.440 -0.006034 -420000.00  5.097e-04    -214.06   -0.210       44.95    0.160      -34.25
      ------------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ---------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =     -291.23 kN.
           -. MnPy   = SUM [ MnPyi ]  =      118.65 kN-m.
           -. MnPz   = SUM [ MnPzi ]  =       40.98 kN-m.

      ( ). Compute nominal capacity(Pn,Mn) of given neutral axis.
           -. Pn     = Cc + Ps               =      228.68 kN.
           -. Mny    = MnCy + MnPy           =      225.32 kN-m.
           -. Mnz    = MnCz + MnPz           =       88.67 kN-m.
           -. Mn     = SQRT(Mny^2+Mnz^2)     =      242.14 kN-m.

      ( ). Compute strength reduction factor.
           -. et      = 0.00855
           -. et_min  = 0.00210
```

```
-. et_max  = 0.00500
-. et > et_max  --->  phi =0.900
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                    Gen 2022
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      ( ). Compute axial load and moment capacities(phiPn,phiMn).
           -. phiPn  = phi*Pn  =      205.81 kN.
           -. phiMn  = phi*Mn  =      217.93 kN-m.
           -. phiMny = phi*Mny =      202.79 kN-m.
           -. phiMnz = phi*Mnz =       79.81 kN-m.

      ( ). Check ratios of axial load and moment capacity.
           -. Rat_P  = Pu/phiPn = 0.997  <  1.000  --->  O.K.
           -. Rat_M  = Mc/phiMn = 0.453  <  1.000  --->  O.K.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   25,  POS = J )
           -. Applied axial force : Pu  =      205.30 kN.
           -. Applied shear force : Vuz =       41.65 kN.
           -. d      = Hc-do    =    0.460 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.184 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      177.65 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      133.24 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   22,  POS = J )
           -. Applied axial force : Pu  =      362.93 kN.
           -. Applied shear force : Vuy =        8.99 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.500 m.
           -. Acv    = Bw*d     =    0.180 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      182.91 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      137.18 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.
```

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----------------------------------------------------------------------------------------
 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   25,  POS = 1/2 )
           -. Applied axial force : Pu  =      213.94 kN.
           -. Applied shear force : Vuz =       41.65 kN.
           -. d      = Hc-do    =    0.460 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.184 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      178.16 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      133.62 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   22,  POS = 1/2 )
           -. Applied axial force : Pu  =      374.45 kN.
           -. Applied shear force : Vuy =        8.99 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.500 m.
           -. Acv    = Bw*d     =    0.180 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      183.57 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      137.68 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.
      *.midas Gen - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = COLUMN ,  MEMB = 14322,  LCB =   26,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     4) : C40*50
        Section Type : Rectangular with Ties (RT)
        Section Height (HTc)            =        4.000 m.
        Section Depth  (Hc)             =        0.500 m.
        Section Width  (Bc)             =        0.400 m.
        Concrete Cover to C.O.R. (do)   =        0.040 m.
        Concrete Strength (fc)          =    28000.000 KPa.
        Modulus of Elasticity (Ec)      =  24870062.324 KPa.
        Main Rebar Strength (fy)        =   420000.000 KPa.
        Ties/Spirals Strength (fys)     =   420000.000 KPa.
        Modulus of Elasticity (Es)      = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

     *.REBAR PATTERN = RT -  4 -  2 - #8          Unit :  m.
        --------------------------------------------------------
           i          dyi           dzi      Rebar          Asi
        --------------------------------------------------------
           1       -0.160       -0.210      1-#8       0.00051
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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          2       -0.160        0.210      1-#8       0.00051
          3        0.160        0.210      1-#8       0.00051
          4        0.160       -0.210      1-#8       0.00051
        --------------------------------------------------------

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

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =   26
           -----------------------------------------------------------------------------
            Load Case              Pu          Myi          Myj          Mzi          Mzj
           -----------------------------------------------------------------------------
            DL                 202.81         0.04        -0.05         0.02        -0.04
            LL                  -0.00         0.00         0.00         0.00         0.00
            DL+LL              202.81         0.04        -0.05         0.02        -0.04
            Others              60.68        96.39        59.03        36.06         0.86
           -----------------------------------------------------------------------------
            DL+LL+Others       263.50        96.43        58.98        36.07         0.82
           -----------------------------------------------------------------------------

      ( ). Compute member end moments(M1,M2).  Unit : kN-m.
           -. For Dead Load(DL).
              My1D =         0.04,   My2D =         0.05
              Mz1D =         0.02,   Mz2D =         0.04
           -. For Gravity Load(DL+LL).
              My1G =         0.04,   My2G =         0.05
              Mz1G =         0.02,   Mz2G =         0.04
           -. For Total Load(DL+LL+WL(EL)).
              My1  =        58.98,   My2  =        96.43
              Mz1  =         0.82,   Mz2  =        36.07

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. Slenderness ratio limits.
              SRy(Braced)   =  34 - 12*| My1/My2 | =   26.660  (Single curvature)
              SRz(Braced)   =  34 - 12*| Mz1/Mz2 | =   33.727  (Single curvature)
           -. Radii of gyration.
              ry     =  0.30*Hc  =    0.150 m.
              rz     =  0.30*Bc  =    0.120 m.
           -. Unbraced lengths.
              Ly     =    4.000 m.
              Lz     =    4.000 m.
           -. Effective length factors.
              Ky     =    1.000
              Kz     =    1.000
           -. SLENy  =  Ky*Ly/ry  =   26.667  >  SRy  --->  SLENDER.
           -. SLENz  =  Kz*Lz/rz  =   33.333  <=  SRz  --->  NOT SLENDER.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute moment magnification factors for major axis(DBy,DSy).
           -. Ec       =  4700*SQRT[fc]                    =  2.4870e+07 KPa.
           -. Ryy      =  Bc*Hc^3/12                       =        0.0042 m^4.
           -. Rse                                          =    8.9989e-05 m^4.
           -. Betadnsy =  Pu_D/Pu                          =   0.7697
           -. EIy      =  (0.2*Ec*Ryy+Es*Rse)/(1+Betadnsy) =    21881.0563 (by N, mm).
           -. Pu       =  Pu_G + Pu_S           =      263.50 kN.
           -. Single Curvature Bending.
           -. Cmy      =        0.85 (Default or User defined value)
           -. Pcy      =  (pi^2*EIy)/(Ky*Ly)^2  =    13497.34 kN.
           -. DBy      =  Cmy/(1-Pu/(0.75*Pcy)) =        0.87
           -. DBy  <  1.0  --->  DBy  =  1.00
           -. DSy    =     1.00 (Default value)

      ( ). Moment magnification factors for minor axis(DBz,DSz).
           -. DBz    =     1.00 (Default value)
           -. DSz    =     1.00 (Default value)

      ( ). Compute minimum moments(Mmin).
           -. emin_y  =  15 mm. + 0.03*Hc   =       0.030 m.
           -. emin_z  =  15 mm. + 0.03*Bc   =       0.027 m.
           -. Mmin_y  =  Pu * emin_y        =        7.90 kN-m.
           -. Mmin_z  =  Pu * emin_z        =        7.11 kN-m.

      ( ). Compute magnified moments. (Pos : I, Local-y : Braced, Local-z : Braced).
           -. No sidesway moments.
              QMb_y  =  My_G   =         0.04 kN-m.
              QMb_z  =  Mz_G   =         0.02 kN-m.
           -. Sidesway moments.
              QMs_y  =  My_S   =        96.39 kN-m.
              QMs_z  =  Mz_S   =        36.06 kN-m.
           -. Compute magnified moments(Mcy,Mcz).
              Mcy(Slender)     =  DBy*MAX(Mmin_y, QMb_y+QMs_y)     =       96.43 kN-m.
              Mcz(No-Slender)  =  DBz*(QMb_z + QMs_z)              =       36.07 kN-m.

      ( ). Check total moment including 2nd-order effects.
           -. Moments due to 1st-order effects.
              Mcy-1st =        96.43 kN-m.
              Mcz-1st =        36.07 kN-m.
           -. Moments due to 2nd-order effects.
              Mcy-2nd = DBy*(QMb_y + QMs_y) =        96.43 kN-m.
              Mcz-2nd = DBz*(QMb_z + QMs_z) =        36.07 kN-m.
           -. Ratio of moment due to 2nd-order effects to moment due to 1st-order effects.
              Mcy-2nd / Mcy-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.
              Mcz-2nd / Mcz-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.

      ( ). Design forces/moments of column(brace).
           -. Axial Force (Compression)      Pu  =      263.50 kN.
           -. Combined Bending Moment        Mc  =      102.95 kN-m.
           -. Bending Moment about Local-y   Mcy =       96.43 kN-m.
           -. Bending Moment about Local-z   Mcz =       36.07 kN-m.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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          -. Shear Force of Local-y         Vuy =        8.68 kN.
          -. Shear Force of Local-z         Vuz =       43.07 kN.

 ===============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC_COLUMN(RC-BRACE).
 ===============================================================================

      ( ). Compute design parameters.
          -. Ag     =              0.2000 m^2.
          -. Ast    =              0.0020 m^2.
          -. Rhot   = Ast/Ag =   0.010194
          -. esu    = fy/Es  =   0.002100
          -. beta1  =   0.8500  ( fc < 28 MPa.)

      ( ). Check the ratio of reinforcement.
          -. Rhomin =   0.010000
          -. Rhomax =   0.040000
          -. Rhot   =   0.010194
             Rhomin < Rhot < Rhomax  --->  O.K !

      ( ). Compute eccentricities of biaxially loaded column.
          -. Ecny   = ABS(Mcz/Pu)     =      0.1369 m.
          -. Ecnz   = ABS(Mcy/Pu)     =      0.3660 m.
          -. Eccn   = ABS(Mc/Pu)      =      0.3907 m.
          -. Rota   = ATAN(Ecny/Ecnz) =     20.5097 deg.
          -. Rotation of neutral axis =     22.6813 deg.

      ( ). Compute concentric axial load capacity.
          -. Po     = (0.85*fc)*(Ag-Ast) + fy*Ast    =     5567.74 kN.
          -. Maximum Axial Load    : Pomax = 0.75*Po =     4175.80 kN.
          -. Maximum Axial Tension : Pt    = -fy*Ast =     -856.26 kN.

     ---------------------------------------------------------------------------
       *. Analysis of balanced condition.
     ---------------------------------------------------------------------------

      ( ). Compute capacity of concrete stress block.
          -. cb     = (0.003/(0.003+esu))*d  =       0.331 m.
          -. ab     = beta1*cb               =       0.282 m.
          -. Acom                            =       0.089 m^2.
          -. DCcy                            =       0.025 m.
          -. DCcz                            =       0.134 m.
          -. Cc     = 0.85*fc*Acom           =     2110.03 kN.
          -. MnCy   = Cc*DCcz                =      282.59 kN-m.
          -. MnCz   = Cc*DCcy                =       53.05 kN-m.

      ( ). Compute capacity of reinforcement.
```

i	dsi	esi	fsi	Asi	Fsi	dzi	MnPyi	dyi	MnPzi
1	0.563	-0.002100	-420000.00	5.097e-04	-214.06	-0.210	44.95	-0.160	34.25
2	0.176	0.001409	281773.87	5.097e-04	143.61	0.210	30.16	-0.160	-22.98

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      3    0.052  0.002526  420000.00  5.097e-04     214.06    0.210       44.95    0.160       34.25
      4    0.440 -0.000983 -196541.76  5.097e-04    -100.17   -0.210       21.04    0.160      -16.03
     ----------------------------------------------------------------------------------------------
     -.Where,
       di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
       esi = Strain in the i-th reinforcement
       fsi = Stress in the i-th reinforcement ( KPa.)
       Asi = Cross-section area of the i-th reinforcement ( m^2.)
       Fsi = Tensile strength of the i-th reinforcement ( kN.)
       dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
       dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
       M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
       M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
     ----------------------------------------------------------------------------------------------------
-----------
          -. Ps     = SUM [ Fsi ]    =       43.44 kN.
          -. MnPy   = SUM [ MnPyi ]  =      141.10 kN-m.
          -. MnPz   = SUM [ MnPzi ]  =       29.49 kN-m.

      ( ). Compute nominal capacity(Pb,Mb) of Balanced Condition.
          -. Pb     = Cc + Ps                 =     2153.47 kN.
          -. Mny    = MnCy + MnPy             =      423.69 kN-m.
          -. Mnz    = MnCz + MnPz             =       82.54 kN-m.
          -. Mb     = SQRT(Mny^2+Mnz^2)       =      431.65 kN-m.

      ( ). Compare actual eccentricity with balanced eccentricity.
          -. Balanced eccentricity : eb   = Mb/Pb        =    0.200 m.
          -. Minimum eccentricity  : Emin (not defined)  =    0.000 m.
          -. Actual eccentricity   : Eccn = Mu/Pu        =    0.391 m.
          -. eb   < Eccn       --->  Tension controls.

     ----------------------------------------------------------------------------
       *. Final analysis with searched neutral axis.
     ----------------------------------------------------------------------------

      ( ). Search for neutral axis......     Unit :  kN.,  m.
          -. P-M calculation method : Keep P constant
         -----------------------------------------------------
         Trial          c       Phi*Pn       Pu       Ratio
         -----------------------------------------------------
           1-st      0.167       399.08     263.496     66.03
           2-nd      0.159       321.68     263.496     81.91
           3-rd      0.155       283.31     263.496     93.01
           4-th      0.153       264.19     263.496     99.74
         -----------------------------------------------------

      ( ). Compute capacity of compression stress block.
          -. a      = beta1*c                 =       0.130 m.
          -. Acom                             =       0.024 m^2.
          -. DCcy                             =       0.088 m.
          -. DCcz                             =       0.203 m.
          -. Cc     = 0.85*fc*Acom            =      565.83 kN.
          -. MnCy   = Cc*DCcz                 =      114.87 kN-m.
          -. MnCz   = Cc*DCcy                 =       49.55 kN-m.

      ( ). Compute capacity of reinforcement.
     ----------------------------------------------------------------------------------------------
      i      dsi       esi         fsi         Asi         Fsi       dzi        MnPyi       dyi       MnPzi
     ----------------------------------------------------------------------------------------------
      1    0.563 -0.008043 -420000.00  5.097e-04    -214.06   -0.210       44.95   -0.160       34.25
      2    0.176 -0.000445  -89033.61  5.097e-04     -45.38    0.210       -9.53   -0.160        7.26
      3    0.052  0.001974  394805.47  5.097e-04     201.22    0.210       42.26    0.160       32.20
```

4	0.440	-0.005623	-420000.00	5.097e-04	-214.06	-0.210	44.95	0.160	-34.25

```
-------------------------------------------------------------------------------------------
 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ----------------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ----------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =     -272.28 kN.
           -. MnPy   = SUM [ MnPyi ]  =      122.63 kN-m.
           -. MnPz   = SUM [ MnPzi ]  =       39.46 kN-m.

      ( ). Compute nominal capacity(Pn,Mn) of given neutral axis.
           -. Pn     = Cc + Ps               =      293.54 kN.
           -. Mny    = MnCy + MnPy           =      237.50 kN-m.
           -. Mnz    = MnCz + MnPz           =       89.00 kN-m.
           -. Mn     = SQRT(Mny^2+Mnz^2)     =      253.63 kN-m.

      ( ). Compute strength reduction factor.
           -. et      = 0.00804
           -. et_min  = 0.00210
           -. et_max  = 0.00500
           -. et > et_max  --->  phi =0.900

      ( ). Compute axial load and moment capacities(phiPn,phiMn).
           -. phiPn  = phi*Pn  =      264.19 kN.
           -. phiMn  = phi*Mn  =      228.27 kN-m.
           -. phiMny = phi*Mny =      213.75 kN-m.
           -. phiMnz = phi*Mnz =       80.10 kN-m.

      ( ). Check ratios of axial load and moment capacity.
           -. Rat_P  = Pu/phiPn = 0.997  <  1.000  --->  O.K.
           -. Rat_M  = Mc/phiMn = 0.451  <  1.000  --->  O.K.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   28,  POS = J )
           -. Applied axial force : Pu  =      246.22 kN.
           -. Applied shear force : Vuz =       43.07 kN.
           -. d      = Hc-do    =    0.460 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.184 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      180.07 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      135.05 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                    Gen 2022
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      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   26,  POS = J )
           -. Applied axial force : Pu  =      246.22 kN.
           -. Applied shear force : Vuy =        8.68 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.500 m.
           -. Acv    = Bw*d     =    0.180 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      176.16 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      132.12 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   28,  POS = 1/2 )
           -. Applied axial force : Pu  =      254.86 kN.
           -. Applied shear force : Vuz =       43.07 kN.
           -. d      = Hc-do    =    0.460 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.184 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      180.58 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      135.44 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   26,  POS = 1/2 )
           -. Applied axial force : Pu  =      254.86 kN.
           -. Applied shear force : Vuy =        8.68 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.500 m.
           -. Acv    = Bw*d     =    0.180 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      176.66 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      132.49 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.
```

PROJECT TITLE : Acueducto Agua Bonita San José del Guaviare

MIDAS	Company	Leandro Castellanos	Client	
	Author	Leandro Castellanos	File Name	Tanque Elevado.rcs

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------------------------------------------------------------------------------------------
 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
==========================================================================================

      *.midas Gen - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = COLUMN ,  MEMB = 14324,  LCB =   25,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     4) : C40*50
        Section Type : Rectangular with Ties (RT)
        Section Height (HTc)            =        4.000 m.
        Section Depth  (Hc)             =        0.500 m.
        Section Width  (Bc)             =        0.400 m.
        Concrete Cover to C.O.R. (do)   =        0.040 m.
        Concrete Strength (fc)          =    28000.000 KPa.
        Modulus of Elasticity (Ec)      =  24870062.324 KPa.
        Main Rebar Strength (fy)        =    420000.000 KPa.
        Ties/Spirals Strength (fys)     =    420000.000 KPa.
        Modulus of Elasticity (Es)      = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

     *.REBAR PATTERN = RT -  4 -  2 - #8          Unit :  m.
        --------------------------------------------------------
           i          dyi          dzi      Rebar          Asi
        --------------------------------------------------------
           1       -0.160       -0.210      1-#8       0.00051
           2       -0.160        0.210      1-#8       0.00051
           3        0.160        0.210      1-#8       0.00051
           4        0.160       -0.210      1-#8       0.00051
        --------------------------------------------------------

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

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =   25
           -------------------------------------------------------------------------------
            Load Case               Pu          Myi          Myj          Mzi          Mzj
           -------------------------------------------------------------------------------
            DL                  161.18        -0.02         0.04        -0.20        -0.23
            LL                   -0.00         0.00         0.00         0.00         0.00
            DL+LL               161.18        -0.02         0.04        -0.20        -0.23
            Others               63.47        81.07        80.20         7.20         9.09
           -------------------------------------------------------------------------------
            DL+LL+Others        224.65        81.05        80.24         7.01         8.87
           -------------------------------------------------------------------------------
```

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----------------------------------------------------------------------------------------
 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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      ( ). Compute member end moments(M1,M2).  Unit : kN-m.
           -. For Dead Load(DL).
              My1D =          0.02,   My2D =         0.04
              Mz1D =          0.20,   Mz2D =         0.23
           -. For Gravity Load(DL+LL).
              My1G =          0.02,   My2G =         0.04
              Mz1G =          0.20,   Mz2G =         0.23
           -. For Total Load(DL+LL+WL(EL)).
              My1  =         80.24,   My2  =        81.05
              Mz1  =          7.01,   Mz2  =         8.87

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. Slenderness ratio limits.
              SRy(Braced)    =  34 - 12*| My1/My2 | =   22.119  (Single curvature)
              SRz(Braced)    =  34 + 12*MIN(|Mz1/Mz2|,0.5) =   40.000  (Reverse curvature)
           -. Radii of gyration.
              ry     =  0.30*Hc  =    0.150 m.
              rz     =  0.30*Bc  =    0.120 m.
           -. Unbraced lengths.
              Ly     =    4.000 m.
              Lz     =    4.000 m.
           -. Effective length factors.
              Ky     =    1.000
              Kz     =    1.000
           -. SLENy  =  Ky*Ly/ry  =   26.667  >  SRy  --->  SLENDER.
           -. SLENz  =  Kz*Lz/rz  =   33.333  <=  SRz  --->  NOT SLENDER.

      ( ). Compute moment magnification factors for major axis(DBy,DSy).
           -. Ec       =  4700*SQRT[fc]                    =  2.4870e+07 KPa.
           -. Ryy      =  Bc*Hc^3/12                       =        0.0042 m^4.
           -. Rse                                          =    8.9989e-05 m^4.
           -. Betadnsy =  Pu_D/Pu                          =   0.7175
           -. EIy      =  (0.2*Ec*Ryy+Es*Rse)/(1+Betadnsy) =    22546.2235 (by N, mm).
           -. Pu       =  Pu_G + Pu_S            =       224.65 kN.
           -. Single Curvature Bending.
           -. Cmy      =        0.85 (Default or User defined value)
           -. Pcy      =  (pi^2*EIy)/(Ky*Ly)^2  =    13907.64 kN.
           -. DBy      =  Cmy/(1-Pu/(0.75*Pcy)) =        0.87
           -. DBy  <  1.0  --->  DBy  =  1.00
           -. DSy    =     1.00 (Default value)

      ( ). Moment magnification factors for minor axis(DBz,DSz).
           -. DBz    =     1.00 (Default value)
           -. DSz    =     1.00 (Default value)

      ( ). Compute minimum moments(Mmin).
           -. emin_y  =  15 mm. + 0.03*Hc   =       0.030 m.
           -. emin_z  =  15 mm. + 0.03*Bc   =       0.027 m.
           -. Mmin_y  =  Pu * emin_y        =        6.74 kN-m.
           -. Mmin_z  =  Pu * emin_z        =        6.07 kN-m.
```

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-------------------------------------------------------------------------------------
 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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      ( ). Compute magnified moments. (Pos : J, Local-y : Braced, Local-z : Braced).
           -. No sidesway moments.
              QMb_y  =  My_G   =        0.04 kN-m.
              QMb_z  =  Mz_G   =       -0.23 kN-m.
           -. Sidesway moments.
              QMs_y  =  My_S   =       80.20 kN-m.
              QMs_z  =  Mz_S   =        9.09 kN-m.
           -. Compute magnified moments(Mcy,Mcz).
              Mcy(Slender)    =  DBy*MAX(Mmin_y, QMb_y+QMs_y)     =       80.24 kN-m.
              Mcz(No-Slender) =  DBz*(QMb_z + QMs_z)              =        8.87 kN-m.

      ( ). Check total moment including 2nd-order effects.
           -. Moments due to 1st-order effects.
              Mcy-1st =        80.24 kN-m.
              Mcz-1st =         8.87 kN-m.
           -. Moments due to 2nd-order effects.
              Mcy-2nd = DBy*(QMb_y + QMs_y) =        80.24 kN-m.
              Mcz-2nd = DBz*(QMb_z + QMs_z) =         8.87 kN-m.
           -. Ratio of moment due to 2nd-order effects to moment due to 1st-order effects.
              Mcy-2nd / Mcy-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.
              Mcz-2nd / Mcz-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.

      ( ). Design forces/moments of column(brace).
           -. Axial Force (Compression)      Pu   =      224.65 kN.
           -. Combined Bending Moment        Mc   =       80.73 kN-m.
           -. Bending Moment about Local-y   Mcy =       80.24 kN-m.
           -. Bending Moment about Local-z   Mcz =        8.87 kN-m.
           -. Shear Force of Local-y         Vuy =        4.15 kN.
           -. Shear Force of Local-z         Vuz =       44.43 kN.

 ==============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC_COLUMN(RC-BRACE).
 ==============================================================================

      ( ). Compute design parameters.
           -. Ag     =              0.2000 m^2.
           -. Ast    =              0.0020 m^2.
           -. Rhot   = Ast/Ag =   0.010194
           -. esu    = fy/Es  =   0.002100
           -. beta1  =   0.8500  ( fc < 28 MPa.)

      ( ). Check the ratio of reinforcement.
           -. Rhomin =   0.010000
           -. Rhomax =   0.040000
           -. Rhot   =   0.010194
              Rhomin < Rhot < Rhomax  --->  O.K !
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute eccentricities of biaxially loaded column.
           -. Ecny   = ABS(Mcz/Pu)      =      0.0395 m.
           -. Ecnz   = ABS(Mcy/Pu)      =      0.3572 m.
           -. Eccn   = ABS(Mc/Pu)       =      0.3594 m.
           -. Rota   = ATAN(Ecny/Ecnz) =      6.3045 deg.
           -. Rotation of neutral axis =      4.7284 deg.

      ( ). Compute concentric axial load capacity.
           -. Po     = (0.85*fc)*(Ag-Ast) + fy*Ast    =     5567.74 kN.
           -. Maximum Axial Load    : Pomax = 0.75*Po =     4175.80 kN.
           -. Maximum Axial Tension : Pt    = -fy*Ast =     -856.26 kN.

     ----------------------------------------------------------------------------
       *. Analysis of balanced condition.
     ----------------------------------------------------------------------------

      ( ). Compute capacity of concrete stress block.
           -. cb     = (0.003/(0.003+esu))*d  =       0.287 m.
           -. ab     = beta1*cb               =       0.244 m.
           -. Acom                            =       0.091 m^2.
           -. DCcy                            =       0.005 m.
           -. DCcz                            =       0.136 m.
           -. Cc     = 0.85*fc*Acom           =     2173.85 kN.
           -. MnCy   = Cc*DCcz                =      294.83 kN-m.
           -. MnCz   = Cc*DCcy                =       10.50 kN-m.

      ( ). Compute capacity of reinforcement.
```

i	dsi	esi	fsi	Asi	Fsi	dzi	MnPyi	dyi	MnPzi
1	0.488	-0.002100	-420000.00	5.097e-04	-214.06	-0.210	44.95	-0.160	34.25
2	0.070	0.002273	420000.00	5.097e-04	214.06	0.210	44.95	-0.160	-34.25
3	0.043	0.002549	420000.00	5.097e-04	214.06	0.210	44.95	0.160	34.25
4	0.462	-0.001824	-364877.55	5.097e-04	-185.97	-0.210	39.05	0.160	-29.76

```
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ----------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =       28.09 kN.
           -. MnPy   = SUM [ MnPyi ]  =      173.91 kN-m.
           -. MnPz   = SUM [ MnPzi ]  =        4.50 kN-m.

      ( ). Compute nominal capacity(Pb,Mb) of Balanced Condition.
           -. Pb     = Cc + Ps                =     2201.95 kN.
           -. Mny    = MnCy + MnPy            =      468.75 kN-m.
           -. Mnz    = MnCz + MnPz            =       14.99 kN-m.
           -. Mb     = SQRT(Mny^2+Mnz^2)      =      468.99 kN-m.

      ( ). Compare actual eccentricity with balanced eccentricity.
           -. Balanced eccentricity : eb   = Mb/Pb          =    0.213 m.
           -. Minimum eccentricity  : Emin (not defined)  =    0.000 m.
           -. Actual eccentricity   : Eccn = Mu/Pu          =    0.359 m.
```

```
-. eb   < Eccn       ---> Tension controls.
```

```
-----------------------------------------------------------------------------------------
 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
=========================================================================================


     ---------------------------------------------------------------------------
       *. Final analysis with searched neutral axis.
     ---------------------------------------------------------------------------

      ( ). Search for neutral axis......     Unit :  kN.,  m.
           -. P-M calculation method : Keep P constant
          -----------------------------------------------------
           Trial          c       Phi*Pn       Pu       Ratio
          -----------------------------------------------------
            1-st      0.085       275.75     224.652     81.47
            2-nd      0.077       179.28     224.652     74.70
            3-rd      0.081       228.46     224.652     98.33
            4-th      0.079       204.13     224.652     89.95
            5-th      0.080       216.36     224.652     96.17
            6-th      0.080       222.42     224.652     99.00
            7-th      0.080       225.45     224.652     99.65
          -----------------------------------------------------

      ( ). Compute capacity of compression stress block.
           -. a      = beta1*c               =      0.068 m.
           -. Acom                           =      0.021 m^2.
           -. DCcy                           =      0.021 m.
           -. DCcz                           =      0.223 m.
           -. Cc     = 0.85*fc*Acom          =     495.54 kN.
           -. MnCy   = Cc*DCcz               =     110.55 kN-m.
           -. MnCz   = Cc*DCcy               =      10.50 kN-m.

      ( ). Compute capacity of reinforcement.
      -----------------------------------------------------------------------------------------------
       i      dsi       esi         fsi        Asi          Fsi      dzi       MnPyi      dyi       MnPzi
      -----------------------------------------------------------------------------------------------
       1    0.488 -0.015207 -420000.00  5.097e-04    -214.06   -0.210       44.95   -0.160       34.25
       2    0.070  0.000406   81214.30  5.097e-04      41.39    0.210        8.69   -0.160       -6.62
       3    0.043  0.001390  278004.33  5.097e-04     141.69    0.210       29.76    0.160       22.67
       4    0.462 -0.014223 -420000.00  5.097e-04    -214.06   -0.210       44.95    0.160      -34.25
      -----------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ----------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =     -245.04 kN.
           -. MnPy   = SUM [ MnPyi ]  =      128.35 kN-m.
           -. MnPz   = SUM [ MnPzi ]  =       16.05 kN-m.

      ( ). Compute nominal capacity(Pn,Mn) of given neutral axis.
           -. Pn     = Cc + Ps               =     250.50 kN.
           -. Mny    = MnCy + MnPy           =     238.91 kN-m.
           -. Mnz    = MnCz + MnPz           =      26.55 kN-m.
           -. Mn     = SQRT(Mny^2+Mnz^2)     =     240.38 kN-m.

      ( ). Compute strength reduction factor.
           -. et      = 0.01521
           -. et_min  = 0.00210
```

```
-. et_max  = 0.00500
-. et > et_max  --->  phi =0.900
```

```
-------------------------------------------------------------------------------------------
 midas Gen - RC-Column Design   [ NSR-10 ]                                    Gen 2022
===========================================================================================


      ( ). Compute axial load and moment capacities(phiPn,phiMn).
           -. phiPn  = phi*Pn  =      225.45 kN.
           -. phiMn  = phi*Mn  =      216.34 kN-m.
           -. phiMny = phi*Mny =      215.02 kN-m.
           -. phiMnz = phi*Mnz =       23.89 kN-m.

      ( ). Check ratios of axial load and moment capacity.
           -. Rat_P  = Pu/phiPn = 0.996  <  1.000  --->  O.K.
           -. Rat_M  = Mc/phiMn = 0.373  <  1.000  --->  O.K.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   28,  POS = J )
           -. Applied axial force : Pu  =      224.65 kN.
           -. Applied shear force : Vuz =       44.43 kN.
           -. d      = Hc-do    =    0.460 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.184 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      178.80 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      134.10 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   25,  POS = J )
           -. Applied axial force : Pu  =      224.65 kN.
           -. Applied shear force : Vuy =        4.15 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.500 m.
           -. Acv    = Bw*d     =    0.180 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      174.91 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      131.18 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.
```

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-----------------------------------------------------------------------------------------
 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
=========================================================================================

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   28,  POS = 1/2 )
           -. Applied axial force : Pu  =      233.29 kN.
           -. Applied shear force : Vuz =       44.43 kN.
           -. d      = Hc-do    =    0.460 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.184 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      179.31 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      134.48 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   26,  POS = 1/2 )
           -. Applied axial force : Pu  =      233.29 kN.
           -. Applied shear force : Vuy =        4.15 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.500 m.
           -. Acv    = Bw*d     =    0.180 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      175.41 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      131.56 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.
      *.midas Gen - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = COLUMN ,  MEMB = 14326,  LCB =   26,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     4) : C40*50
        Section Type : Rectangular with Ties (RT)
        Section Height (HTc)            =        4.000 m.
        Section Depth  (Hc)             =        0.500 m.
        Section Width  (Bc)             =        0.400 m.
        Concrete Cover to C.O.R. (do)   =        0.040 m.
        Concrete Strength (fc)          =    28000.000 KPa.
        Modulus of Elasticity (Ec)      =  24870062.324 KPa.
        Main Rebar Strength (fy)        =   420000.000 KPa.
        Ties/Spirals Strength (fys)     =   420000.000 KPa.
        Modulus of Elasticity (Es)      = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

     *.REBAR PATTERN = RT -  4 -  2 - #8          Unit :  m.
        -------------------------------------------------------
           i          dyi          dzi      Rebar          Asi
        -------------------------------------------------------
           1       -0.160       -0.210      1-#8       0.00051
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
============================================================================================

         2       -0.160        0.210      1-#8       0.00051
         3        0.160        0.210      1-#8       0.00051
         4        0.160       -0.210      1-#8       0.00051
        --------------------------------------------------------

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

     ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
          *.Load combination ID =   26
          -------------------------------------------------------------------------------
           Load Case              Pu          Myi          Myj          Mzi          Mzj
          -------------------------------------------------------------------------------
           DL                 137.57         0.09        -0.49        -0.48         2.90
           LL                  -0.00         0.00         0.00         0.00         0.00
           DL+LL              137.57         0.09        -0.49        -0.48         2.90
           Others              68.15        56.94        91.71         2.78        34.91
          -------------------------------------------------------------------------------
           DL+LL+Others       205.72        57.02        91.22         2.30        37.81
          -------------------------------------------------------------------------------

     ( ). Compute member end moments(M1,M2).  Unit : kN-m.
          -. For Dead Load(DL).
             My1D =         0.09,   My2D =         0.49
             Mz1D =         0.48,   Mz2D =         2.90
          -. For Gravity Load(DL+LL).
             My1G =         0.09,   My2G =         0.49
             Mz1G =         0.48,   Mz2G =         2.90
          -. For Total Load(DL+LL+WL(EL)).
             My1  =        57.02,   My2  =        91.22
             Mz1  =         2.30,   Mz2  =        37.81

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. Slenderness ratio limits.
             SRy(Braced)   =  34 - 12*| My1/My2 | =   26.498  (Single curvature)
             SRz(Braced)   =  34 - 12*| Mz1/Mz2 | =   33.270  (Single curvature)
          -. Radii of gyration.
             ry     =  0.30*Hc  =    0.150 m.
             rz     =  0.30*Bc  =    0.120 m.
          -. Unbraced lengths.
             Ly     =    4.000 m.
             Lz     =    4.000 m.
          -. Effective length factors.
             Ky     =    1.000
             Kz     =    1.000
          -. SLENy  =  Ky*Ly/ry  =   26.667  >  SRy  --->  SLENDER.
          -. SLENz  =  Kz*Lz/rz  =   33.333  >  SRz  --->  SLENDER.
```

PROJECT TITLE : Acueducto Agua Bonita San José del Guaviare

MIDAS	**Company**	Leandro Castellanos	**Client**	
	Author	Leandro Castellanos	**File Name**	Tanque Elevado.rcs

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
=============================================================================================

      ( ). Compute moment magnification factors for major axis(DBy,DSy).
           -. Ec       =  4700*SQRT[fc]                      =  2.4870e+07 KPa.
           -. Ryy      =  Bc*Hc^3/12                         =        0.0042 m^4.
           -. Rse                                            =    8.9989e-05 m^4.
           -. Betadnsy =  Pu_D/Pu                            =   0.6687
           -. EIy      =  (0.2*Ec*Ryy+Es*Rse)/(1+Betadnsy) =    23204.7743 (by N, mm).
           -. Pu       =  Pu_G + Pu_S           =      205.72 kN.
           -. Single Curvature Bending.
           -. Cmy      =         0.85 (Default or User defined value)
           -. Pcy      =  (pi^2*EIy)/(Ky*Ly)^2  =    14313.87 kN.
           -. DBy      =  Cmy/(1-Pu/(0.75*Pcy)) =        0.87
           -. DBy  <  1.0  --->  DBy  =  1.00
           -. DSy    =     1.00 (Default value)

      ( ). Compute moment magnification factors for minor axis(DBz,DSz).
           -. Ec       =  4700*SQRT[fc]                      =  2.4870e+07 KPa.
           -. Rzz      =  Hc*Bc^3/12                         =        0.0027 m^4.
           -. Rse                                            =    5.2273e-05 m^4.
           -. Betadnsz =  Pu_D/Pu                            =   0.6687
           -. EIz      =  (0.2*Ec*Rzz+Es*Rse)/(1+Betadnsz) =    14213.4325 (by N, mm).
           -. Pu       =  Pu_G + Pu_S           =      205.72 kN.
           -. Single Curvature Bending.
           -. Cmz      =         0.85 (Default or User defined value)
           -. Pcz      =  (pi^2*EIz)/(Kz*Lz)^2  =     8767.56 kN.
           -. DBz      =  Cmz/(1-Pu/(0.75*Pcz)) =        0.88
           -. DBz  <  1.0  --->  DBz  =  1.00
           -. DSz    =     1.00 (Default value)

      ( ). Compute minimum moments(Mmin).
           -. emin_y  =  15 mm. + 0.03*Hc   =       0.030 m.
           -. emin_z  =  15 mm. + 0.03*Bc   =       0.027 m.
           -. Mmin_y  =  Pu * emin_y        =        6.17 kN-m.
           -. Mmin_z  =  Pu * emin_z        =        5.55 kN-m.

      ( ). Compute magnified moments. (Pos : J, Local-y : Braced, Local-z : Braced).
           -. No sidesway moments.
              QMb_y  =  My_G   =       -0.49 kN-m.
              QMb_z  =  Mz_G   =        2.90 kN-m.
           -. Sidesway moments.
              QMs_y  =  My_S   =       91.71 kN-m.
              QMs_z  =  Mz_S   =       34.91 kN-m.
           -. Compute magnified moments(Mcy,Mcz).
              Mcy(Slender)    =  DBy*MAX(Mmin_y, QMb_y+QMs_y)     =       91.22 kN-m.
              Mcz(Slender)    =  DBz*MAX(Mmin_z, QMb_z+QMs_z)     =       37.81 kN-m.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Check total moment including 2nd-order effects.
           -. Moments due to 1st-order effects.
              Mcy-1st =        91.22 kN-m.
              Mcz-1st =        37.81 kN-m.
           -. Moments due to 2nd-order effects.
              Mcy-2nd = DBy*(QMb_y + QMs_y) =        91.22 kN-m.
              Mcz-2nd = DBz*(QMb_z + QMs_z) =        37.81 kN-m.
           -. Ratio of moment due to 2nd-order effects to moment due to 1st-order effects.
              Mcy-2nd / Mcy-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.
              Mcz-2nd / Mcz-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.

      ( ). Design forces/moments of column(brace).
           -. Axial Force (Compression)      Pu  =      205.72 kN.
           -. Combined Bending Moment        Mc  =       98.74 kN-m.
           -. Bending Moment about Local-y   Mcy =       91.22 kN-m.
           -. Bending Moment about Local-z   Mcz =       37.81 kN-m.
           -. Shear Force of Local-y         Vuy =        9.01 kN.
           -. Shear Force of Local-z         Vuz =       41.64 kN.

 ===============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC_COLUMN(RC-BRACE).
 ===============================================================================

      ( ). Compute design parameters.
           -. Ag     =             0.2000 m^2.
           -. Ast    =             0.0020 m^2.
           -. Rhot   = Ast/Ag =   0.010194
           -. esu    = fy/Es  =   0.002100
           -. beta1  =   0.8500  ( fc < 28 MPa.)

      ( ). Check the ratio of reinforcement.
           -. Rhomin =   0.010000
           -. Rhomax =   0.040000
           -. Rhot   =   0.010194
              Rhomin < Rhot < Rhomax  --->  O.K !

      ( ). Compute eccentricities of biaxially loaded column.
           -. Ecny   = ABS(Mcz/Pu)     =      0.1838 m.
           -. Ecnz   = ABS(Mcy/Pu)     =      0.4434 m.
           -. Eccn   = ABS(Mc/Pu)      =      0.4800 m.
           -. Rota   = ATAN(Ecny/Ecnz) =     22.5134 deg.
           -. Rotation of neutral axis =     24.6223 deg.

      ( ). Compute concentric axial load capacity.
           -. Po     = (0.85*fc)*(Ag-Ast) + fy*Ast    =     5567.74 kN.
           -. Maximum Axial Load    : Pomax = 0.75*Po =     4175.80 kN.
           -. Maximum Axial Tension : Pt    = -fy*Ast =     -856.26 kN.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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     --------------------------------------------------------------------------------
      *. Analysis of balanced condition.
     --------------------------------------------------------------------------------

      ( ). Compute capacity of concrete stress block.
           -. cb     = (0.003/(0.003+esu))*d  =       0.334 m.
           -. ab     = beta1*cb               =       0.284 m.
           -. Acom                            =       0.088 m^2.
           -. DCcy                            =       0.028 m.
           -. DCcz                            =       0.133 m.
           -. Cc     = 0.85*fc*Acom           =     2102.34 kN.
           -. MnCy   = Cc*DCcz                =      280.12 kN-m.
           -. MnCz   = Cc*DCcy                =       58.17 kN-m.

      ( ). Compute capacity of reinforcement.
      -----------------------------------------------------------------------------------------------------
       i      dsi       esi         fsi         Asi          Fsi      dzi        MnPyi       dyi       MnPzi
      -----------------------------------------------------------------------------------------------------
       1    0.568 -0.002100 -420000.00  5.097e-04    -214.06   -0.210        44.95    -0.160       34.25
       2    0.186  0.001327  265450.15  5.097e-04     135.29    0.210        28.41    -0.160      -21.65
       3    0.053  0.002524  420000.00  5.097e-04     214.06    0.210        44.95     0.160       34.25
       4    0.435 -0.000903 -180649.89  5.097e-04     -92.07   -0.210        19.34     0.160      -14.73
      -----------------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ----------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =       43.22 kN.
           -. MnPy   = SUM [ MnPyi ]  =      137.65 kN-m.
           -. MnPz   = SUM [ MnPzi ]  =       32.12 kN-m.

      ( ). Compute nominal capacity(Pb,Mb) of Balanced Condition.
           -. Pb     = Cc + Ps               =     2145.56 kN.
           -. Mny    = MnCy + MnPy           =      417.77 kN-m.
           -. Mnz    = MnCz + MnPz           =       90.30 kN-m.
           -. Mb     = SQRT(Mny^2+Mnz^2)     =      427.42 kN-m.

      ( ). Compare actual eccentricity with balanced eccentricity.
           -. Balanced eccentricity : eb   = Mb/Pb        =    0.199 m.
           -. Minimum eccentricity  : Emin (not defined)  =    0.000 m.
           -. Actual eccentricity   : Eccn = Mu/Pu        =    0.480 m.
           -. eb   < Eccn       --->  Tension controls.

     --------------------------------------------------------------------------------
      *. Final analysis with searched neutral axis.
     --------------------------------------------------------------------------------

      ( ). Search for neutral axis......     Unit :  kN.,  m.
           -. P-M calculation method : Keep P constant
          ---------------------------------------------------
           Trial          c       Phi*Pn       Pu       Ratio
          ---------------------------------------------------
            1-st      0.135       46.83     205.718   -239.30
```

2-nd	0.144	126.74	205.718	37.68
3-rd	0.148	166.54	205.718	76.48

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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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            4-th      0.150       186.44     205.718     89.66
            5-th      0.151       196.39     205.718     95.25
            6-th      0.152       201.37     205.718     97.84
            7-th      0.152       203.86     205.718     99.09
            8-th      0.152       205.10     205.718     99.70
            9-th      0.152       205.72     205.718    100.00
          -----------------------------------------------------

      ( ). Compute capacity of compression stress block.
           -. a      = beta1*c                =       0.129 m.
           -. Acom                            =       0.022 m^2.
           -. DCcy                            =       0.096 m.
           -. DCcz                            =       0.203 m.
           -. Cc     = 0.85*fc*Acom           =      526.00 kN.
           -. MnCy   = Cc*DCcz                =      106.54 kN-m.
           -. MnCz   = Cc*DCcy                =       50.75 kN-m.

      ( ). Compute capacity of reinforcement.
      ------------------------------------------------------------------------------------------------
       i      dsi       esi         fsi        Asi         Fsi      dzi        MnPyi       dyi       MnPzi
      ------------------------------------------------------------------------------------------------
       1    0.568 -0.008197 -420000.00  5.097e-04    -214.06   -0.210        44.95   -0.160       34.25
       2    0.186 -0.000673 -134526.14  5.097e-04     -68.56    0.210       -14.40   -0.160       10.97
       3    0.053  0.001955  390982.74  5.097e-04     199.27    0.210        41.85    0.160       31.88
       4    0.435 -0.005570 -420000.00  5.097e-04    -214.06   -0.210        44.95    0.160      -34.25
      ------------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ---------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =     -297.42 kN.
           -. MnPy   = SUM [ MnPyi ]  =      117.36 kN-m.
           -. MnPz   = SUM [ MnPzi ]  =       42.85 kN-m.

      ( ). Compute nominal capacity(Pn,Mn) of given neutral axis.
           -. Pn     = Cc + Ps                =      228.58 kN.
           -. Mny    = MnCy + MnPy            =      223.90 kN-m.
           -. Mnz    = MnCz + MnPz            =       93.60 kN-m.
           -. Mn     = SQRT(Mny^2+Mnz^2)      =      242.68 kN-m.

      ( ). Compute strength reduction factor.
           -. et      = 0.00820
           -. et_min  = 0.00210
           -. et_max  = 0.00500
           -. et > et_max  --->  phi =0.900

      ( ). Compute axial load and moment capacities(phiPn,phiMn).
           -. phiPn  = phi*Pn  =      205.72 kN.
           -. phiMn  = phi*Mn  =      218.41 kN-m.
           -. phiMny = phi*Mny =      201.51 kN-m.
           -. phiMnz = phi*Mnz =       84.24 kN-m.

      ( ). Check ratios of axial load and moment capacity.
           -. Rat_P  = Pu/phiPn = 1.000  <  1.000  --->  O.K.
```

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-. Rat_M  = Mc/phiMn = 0.452  <  1.000  ---> O.K.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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 ===============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN ( END ).
 ===============================================================================

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   25,  POS = J )
           -. Applied axial force : Pu  =      205.72 kN.
           -. Applied shear force : Vuz =       41.64 kN.
           -. d      = Hc-do    =    0.460 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.184 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      177.68 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      133.26 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   20,  POS = J )
           -. Applied axial force : Pu  =      365.26 kN.
           -. Applied shear force : Vuy =        9.01 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.500 m.
           -. Acv    = Bw*d     =    0.180 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      183.04 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      137.28 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   25,  POS = 1/2 )
           -. Applied axial force : Pu  =      214.36 kN.
           -. Applied shear force : Vuz =       41.64 kN.
           -. d      = Hc-do    =    0.460 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.184 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      178.19 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      133.64 kN.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   20,  POS = 1/2 )
           -. Applied axial force : Pu  =      376.78 kN.
           -. Applied shear force : Vuy =        9.01 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.500 m.
           -. Acv    = Bw*d     =    0.180 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      183.71 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      137.78 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.
      *.midas Gen - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = COLUMN ,  MEMB = 14328,  LCB =   25,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     4) : C40*50
        Section Type : Rectangular with Ties (RT)
        Section Height (HTc)            =        4.000 m.
        Section Depth  (Hc)             =        0.500 m.
        Section Width  (Bc)             =        0.400 m.
        Concrete Cover to C.O.R. (do)   =        0.040 m.
        Concrete Strength (fc)          =    28000.000 KPa.
        Modulus of Elasticity (Ec)      =  24870062.324 KPa.
        Main Rebar Strength (fy)        =   420000.000 KPa.
        Ties/Spirals Strength (fys)     =   420000.000 KPa.
        Modulus of Elasticity (Es)      = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

     *.REBAR PATTERN = RT -  4 -  2 - #8          Unit :  m.
        -------------------------------------------------------
           i          dyi          dzi      Rebar          Asi
        -------------------------------------------------------
           1       -0.160       -0.210      1-#8       0.00051
           2       -0.160        0.210      1-#8       0.00051
           3        0.160        0.210      1-#8       0.00051
           4        0.160       -0.210      1-#8       0.00051
        -------------------------------------------------------

 ==============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
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 midas Gen - RC-Column Design   [ NSR-10 ]                             Gen 2022
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      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =   25
           ----------------------------------------------------------------------
            Load Case              Pu          Myi          Myj          Mzi          Mzj
           ----------------------------------------------------------------------
            DL                 203.44        -0.04         0.02        -0.02         0.03
            LL                  -0.00         0.00         0.00         0.00         0.00
            DL+LL              203.44        -0.04         0.02        -0.02         0.03
            Others              61.61        96.42        59.17        35.74         1.52
           ----------------------------------------------------------------------
            DL+LL+Others       265.05        96.37        59.19        35.73         1.55
           ----------------------------------------------------------------------

      ( ). Compute member end moments(M1,M2).  Unit : kN-m.
           -. For Dead Load(DL).
              My1D =         0.02,   My2D =         0.04
              Mz1D =         0.02,   Mz2D =         0.03
           -. For Gravity Load(DL+LL).
              My1G =         0.02,   My2G =         0.04
              Mz1G =         0.02,   Mz2G =         0.03
           -. For Total Load(DL+LL+WL(EL)).
              My1  =        59.19,   My2  =        96.37
              Mz1  =         1.55,   Mz2  =        35.73

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. Slenderness ratio limits.
              SRy(Braced)   =  34 - 12*| My1/My2 | =   26.630  (Single curvature)
              SRz(Braced)   =  34 - 12*| Mz1/Mz2 | =   33.480  (Single curvature)
           -. Radii of gyration.
              ry     =  0.30*Hc  =    0.150 m.
              rz     =  0.30*Bc  =    0.120 m.
           -. Unbraced lengths.
              Ly     =    4.000 m.
              Lz     =    4.000 m.
           -. Effective length factors.
              Ky     =    1.000
              Kz     =    1.000
           -. SLENy  =  Ky*Ly/ry  =   26.667  >  SRy  --->  SLENDER.
           -. SLENz  =  Kz*Lz/rz  =   33.333  <=  SRz  --->  NOT SLENDER.

      ( ). Compute moment magnification factors for major axis(DBy,DSy).
           -. Ec       =  4700*SQRT[fc]                   =  2.4870e+07 KPa.
           -. Ryy      =  Bc*Hc^3/12                      =        0.0042 m^4.
           -. Rse                                         =    8.9989e-05 m^4.
           -. Betadnsy =  Pu_D/Pu                         =   0.7676
           -. EIy      =  (0.2*Ec*Ryy+Es*Rse)/(1+Betadnsy) =    21907.4800 (by N, mm).
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 midas Gen - RC-Column Design   [ NSR-10 ]                                   Gen 2022
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           -. Pu       =  Pu_G + Pu_S           =      265.05 kN.
           -. Single Curvature Bending.
           -. Cmy      =        0.85 (Default or User defined value)
           -. Pcy      =  (pi^2*EIy)/(Ky*Ly)^2  =    13513.64 kN.
           -. DBy      =  Cmy/(1-Pu/(0.75*Pcy)) =        0.87
           -. DBy  <  1.0  --->  DBy  =  1.00
           -. DSy    =     1.00 (Default value)

      ( ). Moment magnification factors for minor axis(DBz,DSz).
           -. DBz    =     1.00 (Default value)
           -. DSz    =     1.00 (Default value)

      ( ). Compute minimum moments(Mmin).
           -. emin_y  =  15 mm. + 0.03*Hc   =       0.030 m.
           -. emin_z  =  15 mm. + 0.03*Bc   =       0.027 m.
           -. Mmin_y  =  Pu * emin_y        =        7.95 kN-m.
           -. Mmin_z  =  Pu * emin_z        =        7.16 kN-m.

      ( ). Compute magnified moments. (Pos : I, Local-y : Braced, Local-z : Braced).
           -. No sidesway moments.
              QMb_y  =  My_G   =       -0.04 kN-m.
              QMb_z  =  Mz_G   =       -0.02 kN-m.
           -. Sidesway moments.
              QMs_y  =  My_S   =       96.42 kN-m.
              QMs_z  =  Mz_S   =       35.74 kN-m.
           -. Compute magnified moments(Mcy,Mcz).
              Mcy(Slender)    =  DBy*MAX(Mmin_y, QMb_y+QMs_y)     =       96.37 kN-m.
              Mcz(No-Slender) =  DBz*(QMb_z + QMs_z)              =       35.73 kN-m.

      ( ). Check total moment including 2nd-order effects.
           -. Moments due to 1st-order effects.
              Mcy-1st =        96.37 kN-m.
              Mcz-1st =        35.73 kN-m.
           -. Moments due to 2nd-order effects.
              Mcy-2nd = DBy*(QMb_y + QMs_y) =        96.37 kN-m.
              Mcz-2nd = DBz*(QMb_z + QMs_z) =        35.73 kN-m.
           -. Ratio of moment due to 2nd-order effects to moment due to 1st-order effects.
              Mcy-2nd / Mcy-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.
              Mcz-2nd / Mcz-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.

      ( ). Design forces/moments of column(brace).
           -. Axial Force (Compression)      Pu  =      265.05 kN.
           -. Combined Bending Moment        Mc  =      102.78 kN-m.
           -. Bending Moment about Local-y   Mcy =       96.37 kN-m.
           -. Bending Moment about Local-z   Mcz =       35.73 kN-m.
           -. Shear Force of Local-y         Vuy =        8.41 kN.
           -. Shear Force of Local-z         Vuz =       43.04 kN.

 ===============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC_COLUMN(RC-BRACE).
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MIDAS	Company	Leandro Castellanos	Client	
	Author	Leandro Castellanos	File Name	Tanque Elevado.rcs

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute design parameters.
           -. Ag     =              0.2000 m^2.
           -. Ast    =              0.0020 m^2.
           -. Rhot   = Ast/Ag =   0.010194
           -. esu    = fy/Es  =   0.002100
           -. beta1  =   0.8500  ( fc < 28 MPa.)

      ( ). Check the ratio of reinforcement.
           -. Rhomin =   0.010000
           -. Rhomax =   0.040000
           -. Rhot   =   0.010194
              Rhomin < Rhot < Rhomax  --->  O.K !

      ( ). Compute eccentricities of biaxially loaded column.
           -. Ecny   = ABS(Mcz/Pu)     =      0.1348 m.
           -. Ecnz   = ABS(Mcy/Pu)     =      0.3636 m.
           -. Eccn   = ABS(Mc/Pu)      =      0.3878 m.
           -. Rota   = ATAN(Ecny/Ecnz) =     20.3410 deg.
           -. Rotation of neutral axis =     22.5179 deg.

      ( ). Compute concentric axial load capacity.
           -. Po     = (0.85*fc)*(Ag-Ast) + fy*Ast    =     5567.74 kN.
           -. Maximum Axial Load    : Pomax = 0.75*Po =     4175.80 kN.
           -. Maximum Axial Tension : Pt    = -fy*Ast =     -856.26 kN.

     -----------------------------------------------------------------------------
       *. Analysis of balanced condition.
     -----------------------------------------------------------------------------

      ( ). Compute capacity of concrete stress block.
           -. cb     = (0.003/(0.003+esu))*d  =       0.331 m.
           -. ab     = beta1*cb               =       0.281 m.
           -. Acom                            =       0.089 m^2.
           -. DCcy                            =       0.025 m.
           -. DCcz                            =       0.134 m.
           -. Cc     = 0.85*fc*Acom           =     2110.66 kN.
           -. MnCy   = Cc*DCcz                =      282.78 kN-m.
           -. MnCz   = Cc*DCcy                =       52.62 kN-m.

      ( ). Compute capacity of reinforcement.
```

i	dsi	esi	fsi	Asi	Fsi	dzi	MnPyi	dyi	MnPzi
1	0.563	-0.002100	-420000.00	5.097e-04	-214.06	-0.210	44.95	-0.160	34.25
2	0.175	0.001416	283161.53	5.097e-04	144.32	0.210	30.31	-0.160	-23.09
3	0.052	0.002526	420000.00	5.097e-04	214.06	0.210	44.95	0.160	34.25
4	0.440	-0.000989	-197892.71	5.097e-04	-100.86	-0.210	21.18	0.160	-16.14

```
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ----------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =       43.46 kN.
```

```
-. MnPy   = SUM [ MnPyi ]  =      141.40 kN-m.
-. MnPz   = SUM [ MnPzi ]  =       29.27 kN-m.
```

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( ). Compute nominal capacity(Pb,Mb) of Balanced Condition.
-. Pb = Cc + Ps = 2154.12 kN.
-. Mny = MnCy + MnPy = 424.18 kN-m.
-. Mnz = MnCz + MnPz = 81.90 kN-m.
-. Mb = SQRT(Mny^2+Mnz^2) = 432.01 kN-m.

( ). Compare actual eccentricity with balanced eccentricity.
-. Balanced eccentricity : eb = Mb/Pb = 0.201 m.
-. Minimum eccentricity : Emin (not defined) = 0.000 m.
-. Actual eccentricity : Eccn = Mu/Pu = 0.388 m.
-. eb < Eccn ---> Tension controls.

*. Final analysis with searched neutral axis.

( ). Search for neutral axis...... Unit : kN., m.
-. P-M calculation method : Keep P constant

Trial	c	Phi*Pn	Pu	Ratio
1-st	0.167	402.87	265.052	65.79
2-nd	0.159	325.30	265.052	81.48
3-rd	0.155	286.85	265.052	92.40
4-th	0.153	267.69	265.052	99.01
5-th	0.152	258.13	265.052	97.32
6-th	0.152	262.91	265.052	99.18
7-th	0.153	265.30	265.052	99.91

( ). Compute capacity of compression stress block.
-. a = beta1*c = 0.130 m.
-. Acom = 0.024 m^2.
-. DCcy = 0.087 m.
-. DCcz = 0.203 m.
-. Cc = 0.85*fc*Acom = 566.25 kN.
-. MnCy = Cc*DCcz = 115.05 kN-m.
-. MnCz = Cc*DCcy = 49.30 kN-m.

( ). Compute capacity of reinforcement.

i	dsi	esi	fsi	Asi	Fsi	dzi	MnPyi	dyi	MnPzi
1	0.563	-0.008061	-420000.00	5.097e-04	-214.06	-0.210	44.95	-0.160	34.25
2	0.175	-0.000436	-87177.52	5.097e-04	-44.43	0.210	-9.33	-0.160	7.11
3	0.052	0.001973	394541.57	5.097e-04	201.09	0.210	42.23	0.160	32.17
4	0.440	-0.005653	-420000.00	5.097e-04	-214.06	-0.210	44.95	0.160	-34.25

-.Where,
di = Distance from the section's neutral axis to the i-th reinforcement (m.)
esi = Strain in the i-th reinforcement
fsi = Stress in the i-th reinforcement (KPa.)
Asi = Cross-section area of the i-th reinforcement (m^2.)
Fsi = Tensile strength of the i-th reinforcement (kN.)
dzi = Distance from the center of the section to the i-th reinforcement in the element local z-axis (m.)
dyi = Distance from the center of the section to the i-th reinforcement in the element local y-axis (m.)
M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement (kN-m.)
M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement (kN-m.)

-. Ps = SUM [Fsi] = -271.47 kN.

```
-. MnPy   = SUM [ MnPyi ]  =      122.80 kN-m.
-. MnPz   = SUM [ MnPzi ]  =       39.28 kN-m.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute nominal capacity(Pn,Mn) of given neutral axis.
           -. Pn     = Cc + Ps                =      294.78 kN.
           -. Mny    = MnCy + MnPy            =      237.86 kN-m.
           -. Mnz    = MnCz + MnPz            =       88.59 kN-m.
           -. Mn     = SQRT(Mny^2+Mnz^2)      =      253.82 kN-m.

      ( ). Compute strength reduction factor.
           -. et       = 0.00806
           -. et_min  = 0.00210
           -. et_max  = 0.00500
           -. et > et_max  --->  phi =0.900

      ( ). Compute axial load and moment capacities(phiPn,phiMn).
           -. phiPn  = phi*Pn  =      265.30 kN.
           -. phiMn  = phi*Mn  =      228.44 kN-m.
           -. phiMny = phi*Mny =      214.07 kN-m.
           -. phiMnz = phi*Mnz =       79.73 kN-m.

      ( ). Check ratios of axial load and moment capacity.
           -. Rat_P  = Pu/phiPn = 0.999  <  1.000  --->  O.K.
           -. Rat_M  = Mc/phiMn = 0.450  <  1.000  --->  O.K.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   25,  POS = J )
           -. Applied axial force : Pu  =      247.77 kN.
           -. Applied shear force : Vuz =       43.04 kN.
           -. d      = Hc-do    =    0.460 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.184 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      180.16 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      135.12 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   25,  POS = J )
           -. Applied axial force : Pu  =      247.77 kN.
           -. Applied shear force : Vuy =        8.41 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.500 m.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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           -. Acv    = Bw*d     =    0.180 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      176.25 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      132.19 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   25,  POS = 1/2 )
           -. Applied axial force : Pu  =      256.41 kN.
           -. Applied shear force : Vuz =       43.04 kN.
           -. d      = Hc-do    =    0.460 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.184 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      180.68 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      135.51 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   30,  POS = 1/2 )
           -. Applied axial force : Pu  =      381.60 kN.
           -. Applied shear force : Vuy =        8.67 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.500 m.
           -. Acv    = Bw*d     =    0.180 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      183.99 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      137.99 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      *.midas Gen - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = COLUMN ,  MEMB = 14330,  LCB =   26,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     4) : C40*50
        Section Type : Rectangular with Ties (RT)
        Section Height (HTc)            =        4.000 m.
        Section Depth  (Hc)             =        0.500 m.
        Section Width  (Bc)             =        0.400 m.
        Concrete Cover to C.O.R. (do)   =        0.040 m.
        Concrete Strength (fc)          =    28000.000 KPa.
        Modulus of Elasticity (Ec)      =  24870062.324 KPa.
        Main Rebar Strength (fy)        =   420000.000 KPa.
        Ties/Spirals Strength (fys)     =   420000.000 KPa.
        Modulus of Elasticity (Es)      = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

     *.REBAR PATTERN = RT -  4 -  2 - #8          Unit :  m.
        --------------------------------------------------------
           i          dyi          dzi      Rebar          Asi
        --------------------------------------------------------
           1       -0.160       -0.210      1-#8       0.00051
           2       -0.160        0.210      1-#8       0.00051
           3        0.160        0.210      1-#8       0.00051
           4        0.160       -0.210      1-#8       0.00051
        --------------------------------------------------------

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

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =   26
           -------------------------------------------------------------------------------
            Load Case              Pu           Myi           Myj           Mzi           Mzj
           -------------------------------------------------------------------------------
            DL                 161.86         -0.04          0.03          0.19          0.19
            LL                  -0.00          0.00          0.00          0.00          0.00
            DL+LL              161.86         -0.04          0.03          0.19          0.19
            Others              64.42         81.08         80.16          8.12         10.78
           -------------------------------------------------------------------------------
            DL+LL+Others       226.28         81.04         80.19          8.30         10.98
           -------------------------------------------------------------------------------
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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      ( ). Compute member end moments(M1,M2).  Unit : kN-m.
           -. For Dead Load(DL).
              My1D =          0.03,   My2D =          0.04
              Mz1D =          0.19,   Mz2D =          0.19
           -. For Gravity Load(DL+LL).
              My1G =          0.03,   My2G =          0.04
              Mz1G =          0.19,   Mz2G =          0.19
           -. For Total Load(DL+LL+WL(EL)).
              My1  =         80.19,   My2  =         81.04
              Mz1  =          8.30,   Mz2  =         10.98

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. Slenderness ratio limits.
              SRy(Braced)    =  34 - 12*| My1/My2 | =   22.127  (Single curvature)
              SRz(Braced)    =  34 - 12*| Mz1/Mz2 | =   24.925  (Single curvature)
           -. Radii of gyration.
              ry     =  0.30*Hc  =    0.150 m.
              rz     =  0.30*Bc  =    0.120 m.
           -. Unbraced lengths.
              Ly     =    4.000 m.
              Lz     =    4.000 m.
           -. Effective length factors.
              Ky     =    1.000
              Kz     =    1.000
           -. SLENy  =  Ky*Ly/ry  =   26.667  >  SRy  --->  SLENDER.
           -. SLENz  =  Kz*Lz/rz  =   33.333  >  SRz  --->  SLENDER.

      ( ). Compute moment magnification factors for major axis(DBy,DSy).
           -. Ec       =  4700*SQRT[fc]                    =  2.4870e+07 KPa.
           -. Ryy      =  Bc*Hc^3/12                       =        0.0042 m^4.
           -. Rse                                          =    8.9989e-05 m^4.
           -. Betadnsy =  Pu_D/Pu                          =   0.7153
           -. EIy      =  (0.2*Ec*Ryy+Es*Rse)/(1+Betadnsy) =    22574.7357 (by N, mm).
           -. Pu       =  Pu_G + Pu_S           =       226.28 kN.
           -. Single Curvature Bending.
           -. Cmy      =         0.85 (Default or User defined value)
           -. Pcy      =  (pi^2*EIy)/(Ky*Ly)^2  =    13925.23 kN.
           -. DBy      =  Cmy/(1-Pu/(0.75*Pcy)) =        0.87
           -. DBy  <  1.0  --->  DBy  =  1.00
           -. DSy    =     1.00 (Default value)

      ( ). Compute moment magnification factors for minor axis(DBz,DSz).
           -. Ec       =  4700*SQRT[fc]                    =  2.4870e+07 KPa.
           -. Rzz      =  Hc*Bc^3/12                       =        0.0027 m^4.
           -. Rse                                          =    5.2273e-05 m^4.
           -. Betadnsz =  Pu_D/Pu                          =   0.7153
           -. EIz      =  (0.2*Ec*Rzz+Es*Rse)/(1+Betadnsz) =    13827.5200 (by N, mm).
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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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           -. Pu       =  Pu_G + Pu_S           =      226.28 kN.
           -. Single Curvature Bending.
           -. Cmz      =        0.85 (Default or User defined value)
           -. Pcz      =  (pi^2*EIz)/(Kz*Lz)^2  =     8529.51 kN.
           -. DBz      =  Cmz/(1-Pu/(0.75*Pcz)) =        0.88
           -. DBz  <  1.0  --->  DBz  =  1.00
           -. DSz    =     1.00 (Default value)

      ( ). Compute minimum moments(Mmin).
           -. emin_y  =  15 mm. + 0.03*Hc    =       0.030 m.
           -. emin_z  =  15 mm. + 0.03*Bc    =       0.027 m.
           -. Mmin_y  =  Pu * emin_y         =        6.79 kN-m.
           -. Mmin_z  =  Pu * emin_z         =        6.11 kN-m.

      ( ). Compute magnified moments. (Pos : J, Local-y : Braced, Local-z : Braced).
           -. No sidesway moments.
              QMb_y  =  My_G   =        0.03 kN-m.
              QMb_z  =  Mz_G   =        0.19 kN-m.
           -. Sidesway moments.
              QMs_y  =  My_S   =       80.16 kN-m.
              QMs_z  =  Mz_S   =       10.78 kN-m.
           -. Compute magnified moments(Mcy,Mcz).
              Mcy(Slender)    =  DBy*MAX(Mmin_y, QMb_y+QMs_y)     =       80.19 kN-m.
              Mcz(Slender)    =  DBz*MAX(Mmin_z, QMb_z+QMs_z)     =       10.98 kN-m.

      ( ). Check total moment including 2nd-order effects.
           -. Moments due to 1st-order effects.
              Mcy-1st =        80.19 kN-m.
              Mcz-1st =        10.98 kN-m.
           -. Moments due to 2nd-order effects.
              Mcy-2nd = DBy*(QMb_y + QMs_y) =        80.19 kN-m.
              Mcz-2nd = DBz*(QMb_z + QMs_z) =        10.98 kN-m.
           -. Ratio of moment due to 2nd-order effects to moment due to 1st-order effects.
              Mcy-2nd / Mcy-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.
              Mcz-2nd / Mcz-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.

      ( ). Design forces/moments of column(brace).
           -. Axial Force (Compression)      Pu   =      226.28 kN.
           -. Combined Bending Moment        Mc   =       80.93 kN-m.
           -. Bending Moment about Local-y   Mcy =       80.19 kN-m.
           -. Bending Moment about Local-z   Mcz =       10.98 kN-m.
           -. Shear Force of Local-y         Vuy =        4.14 kN.
           -. Shear Force of Local-z         Vuz =       44.43 kN.

 ===============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC_COLUMN(RC-BRACE).
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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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      ( ). Compute design parameters.
           -. Ag     =              0.2000 m^2.
           -. Ast    =              0.0020 m^2.
           -. Rhot   = Ast/Ag =   0.010194
           -. esu    = fy/Es  =   0.002100
           -. beta1  =   0.8500  ( fc < 28 MPa.)

      ( ). Check the ratio of reinforcement.
           -. Rhomin =   0.010000
           -. Rhomax =   0.040000
           -. Rhot   =   0.010194
              Rhomin < Rhot < Rhomax  --->  O.K !

      ( ). Compute eccentricities of biaxially loaded column.
           -. Ecny   = ABS(Mcz/Pu)     =      0.0485 m.
           -. Ecnz   = ABS(Mcy/Pu)     =      0.3544 m.
           -. Eccn   = ABS(Mc/Pu)      =      0.3577 m.
           -. Rota   = ATAN(Ecny/Ecnz) =      7.7950 deg.
           -. Rotation of neutral axis =      5.8463 deg.

      ( ). Compute concentric axial load capacity.
           -. Po     = (0.85*fc)*(Ag-Ast) + fy*Ast    =     5567.74 kN.
           -. Maximum Axial Load    : Pomax = 0.75*Po =     4175.80 kN.
           -. Maximum Axial Tension : Pt    = -fy*Ast =     -856.26 kN.

     ----------------------------------------------------------------------------
       *. Analysis of balanced condition.
     ----------------------------------------------------------------------------

      ( ). Compute capacity of concrete stress block.
           -. cb     = (0.003/(0.003+esu))*d  =       0.291 m.
           -. ab     = beta1*cb               =       0.247 m.
           -. Acom                            =       0.091 m^2.
           -. DCcy                            =       0.006 m.
           -. DCcz                            =       0.136 m.
           -. Cc     = 0.85*fc*Acom           =     2170.10 kN.
           -. MnCy   = Cc*DCcz                =      294.52 kN-m.
           -. MnCz   = Cc*DCcy                =       13.00 kN-m.

      ( ). Compute capacity of reinforcement.
```

i	dsi	esi	fsi	Asi	Fsi	dzi	MnPyi	dyi	MnPzi
1	0.494	-0.002100	-420000.00	5.097e-04	-214.06	-0.210	44.95	-0.160	34.25
2	0.076	0.002211	420000.00	5.097e-04	214.06	0.210	44.95	-0.160	-34.25
3	0.044	0.002547	420000.00	5.097e-04	214.06	0.210	44.95	0.160	34.25
4	0.462	-0.001764	-352736.28	5.097e-04	-179.78	-0.210	37.75	0.160	-28.77

```
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      -----------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =       34.28 kN.
```

```
-. MnPy   = SUM [ MnPyi ]  =      172.61 kN-m.
-. MnPz   = SUM [ MnPzi ]  =        5.49 kN-m.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute nominal capacity(Pb,Mb) of Balanced Condition.
           -. Pb     = Cc + Ps                =     2204.39 kN.
           -. Mny    = MnCy + MnPy            =      467.14 kN-m.
           -. Mnz    = MnCz + MnPz            =       18.48 kN-m.
           -. Mb     = SQRT(Mny^2+Mnz^2)      =      467.50 kN-m.

      ( ). Compare actual eccentricity with balanced eccentricity.
           -. Balanced eccentricity : eb   = Mb/Pb        =    0.212 m.
           -. Minimum eccentricity  : Emin (not defined)  =    0.000 m.
           -. Actual eccentricity   : Eccn = Mu/Pu        =    0.358 m.
           -. eb   < Eccn       --->  Tension controls.

     ----------------------------------------------------------------------------
       *. Final analysis with searched neutral axis.
     ----------------------------------------------------------------------------

      ( ). Search for neutral axis......     Unit :  kN.,  m.
           -. P-M calculation method : Keep P constant
          -----------------------------------------------------
           Trial          c       Phi*Pn       Pu       Ratio
          -----------------------------------------------------
            1-st      0.086       231.07     226.283     97.93
            2-nd      0.078       131.68     226.283     28.16
            3-rd      0.082       182.37     226.283     75.92
            4-th      0.084       206.95     226.283     90.66
            5-th      0.085       219.07     226.283     96.71
            6-th      0.085       225.08     226.283     99.47
            7-th      0.085       228.08     226.283     99.21
            8-th      0.085       226.58     226.283     99.87
          -----------------------------------------------------

      ( ). Compute capacity of compression stress block.
           -. a      = beta1*c                =       0.073 m.
           -. Acom                            =       0.021 m^2.
           -. DCcy                            =       0.026 m.
           -. DCcz                            =       0.222 m.
           -. Cc     = 0.85*fc*Acom           =      499.37 kN.
           -. MnCy   = Cc*DCcz                =      111.08 kN-m.
           -. MnCz   = Cc*DCcy                =       13.00 kN-m.

      ( ). Compute capacity of reinforcement.
      -----------------------------------------------------------------------------------------------
       i      dsi       esi         fsi         Asi          Fsi       dzi        MnPyi      dyi       MnPzi
      -----------------------------------------------------------------------------------------------
       1    0.494 -0.014372 -420000.00  5.097e-04    -214.06   -0.210       44.95   -0.160       34.25
       2    0.076  0.000313   62530.80  5.097e-04      31.87    0.210        6.69   -0.160       -5.10
       3    0.044  0.001458  291650.65  5.097e-04     148.65    0.210       31.22    0.160       23.78
       4    0.462 -0.013226 -420000.00  5.097e-04    -214.06   -0.210       44.95    0.160      -34.25
```

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--------------------------------------------------------------------------------------------
 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      -----------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ----------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =     -247.61 kN.
           -. MnPy   = SUM [ MnPyi ]  =      127.82 kN-m.
           -. MnPz   = SUM [ MnPzi ]  =       18.68 kN-m.

      ( ). Compute nominal capacity(Pn,Mn) of given neutral axis.
           -. Pn     = Cc + Ps                =      251.76 kN.
           -. Mny    = MnCy + MnPy            =      238.89 kN-m.
           -. Mnz    = MnCz + MnPz            =       31.68 kN-m.
           -. Mn     = SQRT(Mny^2+Mnz^2)      =      240.99 kN-m.

      ( ). Compute strength reduction factor.
           -. et      = 0.01437
           -. et_min  = 0.00210
           -. et_max  = 0.00500
           -. et > et_max  --->  phi =0.900

      ( ). Compute axial load and moment capacities(phiPn,phiMn).
           -. phiPn  = phi*Pn  =      226.58 kN.
           -. phiMn  = phi*Mn  =      216.89 kN-m.
           -. phiMny = phi*Mny =      215.01 kN-m.
           -. phiMnz = phi*Mnz =       28.51 kN-m.

      ( ). Check ratios of axial load and moment capacity.
           -. Rat_P  = Pu/phiPn = 0.999  <  1.000  --->  O.K.
           -. Rat_M  = Mc/phiMn = 0.373  <  1.000  --->  O.K.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   25,  POS = J )
           -. Applied axial force : Pu  =      226.28 kN.
           -. Applied shear force : Vuz =       44.43 kN.
           -. d      = Hc-do    =    0.460 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.184 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      178.89 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      134.17 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   30,  POS = J )
           -. Applied axial force : Pu  =      346.39 kN.
           -. Applied shear force : Vuy =        4.14 kN.
           -. d      = Bc-do     =    0.360 m.
           -. Bw     = Hc        =    0.500 m.
           -. Acv    = Bw*d      =    0.180 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      181.95 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc    =      136.46 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   25,  POS = 1/2 )
           -. Applied axial force : Pu  =      234.92 kN.
           -. Applied shear force : Vuz =       44.43 kN.
           -. d      = Hc-do     =    0.460 m.
           -. Bw     = Bc        =    0.400 m.
           -. Acv    = Bw*d      =    0.184 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      179.41 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc    =      134.55 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   30,  POS = 1/2 )
           -. Applied axial force : Pu  =      355.03 kN.
           -. Applied shear force : Vuy =        4.14 kN.
           -. d      = Bc-do     =    0.360 m.
           -. Bw     = Hc        =    0.500 m.
           -. Acv    = Bw*d      =    0.180 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      182.45 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc    =      136.84 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      *.midas Gen - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = COLUMN ,  MEMB = 14332,  LCB =   25,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     4) : C40*50
        Section Type : Rectangular with Ties (RT)
        Section Height (HTc)            =        4.000 m.
        Section Depth  (Hc)             =        0.500 m.
        Section Width  (Bc)             =        0.400 m.
        Concrete Cover to C.O.R. (do)   =        0.040 m.
        Concrete Strength (fc)          =    28000.000 KPa.
        Modulus of Elasticity (Ec)      =  24870062.324 KPa.
        Main Rebar Strength (fy)        =   420000.000 KPa.
        Ties/Spirals Strength (fys)     =   420000.000 KPa.
        Modulus of Elasticity (Es)      = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

     *.REBAR PATTERN = RT -  4 -  2 - #8         Unit :  m.
        -------------------------------------------------------
           i          dyi          dzi      Rebar          Asi
        -------------------------------------------------------
           1       -0.160       -0.210      1-#8       0.00051
           2       -0.160        0.210      1-#8       0.00051
           3        0.160        0.210      1-#8       0.00051
           4        0.160       -0.210      1-#8       0.00051
        -------------------------------------------------------

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

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =   25
           ------------------------------------------------------------------------------
            Load Case              Pu           Myi           Myj           Mzi           Mzj
           ------------------------------------------------------------------------------
            DL                 138.34         -0.04          0.07          0.44         -2.84
            LL                  -0.00          0.00          0.00          0.00          0.00
            DL+LL              138.34         -0.04          0.07          0.44         -2.84
            Others              69.15         57.02         93.03          5.69         15.80
           ------------------------------------------------------------------------------
            DL+LL+Others       207.48         56.98         93.10          6.14         12.96
           ------------------------------------------------------------------------------
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                    Gen 2022
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      ( ). Compute member end moments(M1,M2).  Unit : kN-m.
           -. For Dead Load(DL).
              My1D =          0.04,   My2D =          0.07
              Mz1D =          0.44,   Mz2D =          2.84
           -. For Gravity Load(DL+LL).
              My1G =          0.04,   My2G =          0.07
              Mz1G =          0.44,   Mz2G =          2.84
           -. For Total Load(DL+LL+WL(EL)).
              My1  =         56.98,   My2  =         93.10
              Mz1  =          6.14,   Mz2  =         12.96

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. Slenderness ratio limits.
              SRy(Braced)   =  34 - 12*| My1/My2 | =   26.656  (Single curvature)
              SRz(Braced)   =  34 - 12*| Mz1/Mz2 | =   28.314  (Single curvature)
           -. Radii of gyration.
              ry     =  0.30*Hc  =    0.150 m.
              rz     =  0.30*Bc  =    0.120 m.
           -. Unbraced lengths.
              Ly     =    4.000 m.
              Lz     =    4.000 m.
           -. Effective length factors.
              Ky     =    1.000
              Kz     =    1.000
           -. SLENy  =  Ky*Ly/ry  =   26.667  >  SRy  --->  SLENDER.
           -. SLENz  =  Kz*Lz/rz  =   33.333  >  SRz  --->  SLENDER.

      ( ). Compute moment magnification factors for major axis(DBy,DSy).
           -. Ec       =  4700*SQRT[fc]                    =  2.4870e+07 KPa.
           -. Ryy      =  Bc*Hc^3/12                       =        0.0042 m^4.
           -. Rse                                          =    8.9989e-05 m^4.
           -. Betadnsy =  Pu_D/Pu                          =   0.6667
           -. EIy      =  (0.2*Ec*Ryy+Es*Rse)/(1+Betadnsy) =    23232.7131 (by N, mm).
           -. Pu       =  Pu_G + Pu_S           =       207.48 kN.
           -. Single Curvature Bending.
           -. Cmy      =        0.85 (Default or User defined value)
           -. Pcy      =  (pi^2*EIy)/(Ky*Ly)^2  =    14331.11 kN.
           -. DBy      =  Cmy/(1-Pu/(0.75*Pcy)) =        0.87
           -. DBy  <  1.0  --->  DBy  =  1.00
           -. DSy    =     1.00 (Default value)

      ( ). Compute moment magnification factors for minor axis(DBz,DSz).
           -. Ec       =  4700*SQRT[fc]                    =  2.4870e+07 KPa.
           -. Rzz      =  Hc*Bc^3/12                       =        0.0027 m^4.
           -. Rse                                          =    5.2273e-05 m^4.
           -. Betadnsz =  Pu_D/Pu                          =   0.6667
           -. EIz      =  (0.2*Ec*Rzz+Es*Rse)/(1+Betadnsz) =    14230.5456 (by N, mm).
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 midas Gen - RC-Column Design   [ NSR-10 ]                              Gen 2022
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          -. Pu       =  Pu_G + Pu_S           =      207.48 kN.
          -. Single Curvature Bending.
          -. Cmz      =        0.85 (Default or User defined value)
          -. Pcz      =  (pi^2*EIz)/(Kz*Lz)^2  =     8778.12 kN.
          -. DBz      =  Cmz/(1-Pu/(0.75*Pcz)) =        0.88
          -. DBz  <  1.0  --->  DBz  =  1.00
          -. DSz    =     1.00 (Default value)

      ( ). Compute minimum moments(Mmin).
          -. emin_y  =  15 mm. + 0.03*Hc    =       0.030 m.
          -. emin_z  =  15 mm. + 0.03*Bc    =       0.027 m.
          -. Mmin_y  =  Pu * emin_y         =        6.22 kN-m.
          -. Mmin_z  =  Pu * emin_z         =        5.60 kN-m.

      ( ). Compute magnified moments. (Pos : J, Local-y : Braced, Local-z : Braced).
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.07 kN-m.
             QMb_z  =  Mz_G   =       -2.84 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       93.03 kN-m.
             QMs_z  =  Mz_S   =       15.80 kN-m.
          -. Compute magnified moments(Mcy,Mcz).
             Mcy(Slender)    =  DBy*MAX(Mmin_y, QMb_y+QMs_y)     =       93.10 kN-m.
             Mcz(Slender)    =  DBz*MAX(Mmin_z, QMb_z+QMs_z)     =       12.96 kN-m.

      ( ). Check total moment including 2nd-order effects.
          -. Moments due to 1st-order effects.
             Mcy-1st =        93.10 kN-m.
             Mcz-1st =        12.96 kN-m.
          -. Moments due to 2nd-order effects.
             Mcy-2nd = DBy*(QMb_y + QMs_y) =        93.10 kN-m.
             Mcz-2nd = DBz*(QMb_z + QMs_z) =        12.96 kN-m.
          -. Ratio of moment due to 2nd-order effects to moment due to 1st-order effects.
             Mcy-2nd / Mcy-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.
             Mcz-2nd / Mcz-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.

      ( ). Design forces/moments of column(brace).
          -. Axial Force (Compression)      Pu   =      207.48 kN.
          -. Combined Bending Moment        Mc   =       94.00 kN-m.
          -. Bending Moment about Local-y   Mcy =       93.10 kN-m.
          -. Bending Moment about Local-z   Mcz =       12.96 kN-m.
          -. Shear Force of Local-y         Vuy =        9.08 kN.
          -. Shear Force of Local-z         Vuz =       41.56 kN.

 ==============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC_COLUMN(RC-BRACE).
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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute design parameters.
           -. Ag     =              0.2000 m^2.
           -. Ast    =              0.0020 m^2.
           -. Rhot   = Ast/Ag =   0.010194
           -. esu    = fy/Es  =   0.002100
           -. beta1  =   0.8500  ( fc < 28 MPa.)

      ( ). Check the ratio of reinforcement.
           -. Rhomin =   0.010000
           -. Rhomax =   0.040000
           -. Rhot   =   0.010194
              Rhomin < Rhot < Rhomax  --->  O.K !

      ( ). Compute eccentricities of biaxially loaded column.
           -. Ecny   = ABS(Mcz/Pu)     =      0.0624 m.
           -. Ecnz   = ABS(Mcy/Pu)     =      0.4487 m.
           -. Eccn   = ABS(Mc/Pu)      =      0.4530 m.
           -. Rota   = ATAN(Ecny/Ecnz) =      7.9220 deg.
           -. Rotation of neutral axis =      5.9415 deg.

      ( ). Compute concentric axial load capacity.
           -. Po     = (0.85*fc)*(Ag-Ast) + fy*Ast    =     5567.74 kN.
           -. Maximum Axial Load    : Pomax = 0.75*Po =     4175.80 kN.
           -. Maximum Axial Tension : Pt    = -fy*Ast =     -856.26 kN.

     ----------------------------------------------------------------------------
       *. Analysis of balanced condition.
     ----------------------------------------------------------------------------

      ( ). Compute capacity of concrete stress block.
           -. cb     = (0.003/(0.003+esu))*d  =       0.291 m.
           -. ab     = beta1*cb               =       0.247 m.
           -. Acom                            =       0.091 m^2.
           -. DCcy                            =       0.006 m.
           -. DCcz                            =       0.136 m.
           -. Cc     = 0.85*fc*Acom           =     2169.78 kN.
           -. MnCy   = Cc*DCcz                =      294.49 kN-m.
           -. MnCz   = Cc*DCcy                =       13.21 kN-m.

      ( ). Compute capacity of reinforcement.
```

i	dsi	esi	fsi	Asi	Fsi	dzi	MnPyi	dyi	MnPzi
1	0.495	-0.002100	-420000.00	5.097e-04	-214.06	-0.210	44.95	-0.160	34.25
2	0.077	0.002206	420000.00	5.097e-04	214.06	0.210	44.95	-0.160	-34.25
3	0.044	0.002547	420000.00	5.097e-04	214.06	0.210	44.95	0.160	34.25
4	0.462	-0.001759	-351715.60	5.097e-04	-179.26	-0.210	37.64	0.160	-28.68

```
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ----------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =       34.80 kN.
```

```
-. MnPy   = SUM [ MnPyi ]  =      172.51 kN-m.
-. MnPz   = SUM [ MnPzi ]  =        5.57 kN-m.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute nominal capacity(Pb,Mb) of Balanced Condition.
           -. Pb     = Cc + Ps                =     2204.59 kN.
           -. Mny    = MnCy + MnPy            =      467.00 kN-m.
           -. Mnz    = MnCz + MnPz            =       18.78 kN-m.
           -. Mb     = SQRT(Mny^2+Mnz^2)      =      467.37 kN-m.

      ( ). Compare actual eccentricity with balanced eccentricity.
           -. Balanced eccentricity : eb   = Mb/Pb        =    0.212 m.
           -. Minimum eccentricity  : Emin (not defined)  =    0.000 m.
           -. Actual eccentricity   : Eccn = Mu/Pu        =    0.453 m.
           -. eb   < Eccn       --->  Tension controls.

     ----------------------------------------------------------------------------
       *. Final analysis with searched neutral axis.
     ----------------------------------------------------------------------------

      ( ). Search for neutral axis......     Unit :  kN.,  m.
           -. P-M calculation method : Keep P constant
          -----------------------------------------------------
           Trial          c       Phi*Pn       Pu       Ratio
          -----------------------------------------------------
            1-st      0.086       227.28     207.484     91.29
            2-nd      0.078       127.65     207.484     37.45
            3-rd      0.082       178.46     207.484     83.74
            4-th      0.084       203.10     207.484     97.84
            5-th      0.085       215.25     207.484     96.39
            6-th      0.084       209.19     207.484     99.18
            7-th      0.084       206.15     207.484     99.35
            8-th      0.084       207.67     207.484     99.91
          -----------------------------------------------------

      ( ). Compute capacity of compression stress block.
           -. a      = beta1*c                =       0.072 m.
           -. Acom                            =       0.020 m^2.
           -. DCcy                            =       0.027 m.
           -. DCcz                            =       0.223 m.
           -. Cc     = 0.85*fc*Acom           =      486.73 kN.
           -. MnCy   = Cc*DCcz                =      108.55 kN-m.
           -. MnCz   = Cc*DCcy                =       13.21 kN-m.

      ( ). Compute capacity of reinforcement.
      ------------------------------------------------------------------------------------------------
       i      dsi       esi         fsi         Asi         Fsi       dzi        MnPyi       dyi        MnPzi
      ------------------------------------------------------------------------------------------------
       1    0.495 -0.014633 -420000.00  5.097e-04    -214.06   -0.210        44.95   -0.160        34.25
       2    0.077  0.000254   50833.59  5.097e-04      25.91    0.210         5.44   -0.160        -4.15
       3    0.044  0.001435  286923.59  5.097e-04     146.24    0.210        30.71    0.160        23.40
       4    0.462 -0.013453 -420000.00  5.097e-04    -214.06   -0.210        44.95    0.160       -34.25
```

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-------------------------------------------------------------------------------------------
 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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      ------------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ---------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =     -255.98 kN.
           -. MnPy   = SUM [ MnPyi ]  =      126.06 kN-m.
           -. MnPz   = SUM [ MnPzi ]  =       19.25 kN-m.

      ( ). Compute nominal capacity(Pn,Mn) of given neutral axis.
           -. Pn     = Cc + Ps                 =      230.74 kN.
           -. Mny    = MnCy + MnPy             =      234.61 kN-m.
           -. Mnz    = MnCz + MnPz             =       32.46 kN-m.
           -. Mn     = SQRT(Mny^2+Mnz^2)       =      236.84 kN-m.

      ( ). Compute strength reduction factor.
           -. et       = 0.01463
           -. et_min   = 0.00210
           -. et_max   = 0.00500
           -. et > et_max  --->  phi =0.900

      ( ). Compute axial load and moment capacities(phiPn,phiMn).
           -. phiPn  = phi*Pn  =      207.67 kN.
           -. phiMn  = phi*Mn  =      213.16 kN-m.
           -. phiMny = phi*Mny =      211.15 kN-m.
           -. phiMnz = phi*Mnz =       29.22 kN-m.

      ( ). Check ratios of axial load and moment capacity.
           -. Rat_P  = Pu/phiPn = 0.999  <  1.000  --->  O.K.
           -. Rat_M  = Mc/phiMn = 0.441  <  1.000  --->  O.K.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   26,  POS = J )
           -. Applied axial force : Pu  =      207.48 kN.
           -. Applied shear force : Vuz =       41.56 kN.
           -. d      = Hc-do    =    0.460 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.184 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      177.78 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      133.34 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   16,  POS = J )
           -. Applied axial force : Pu  =      253.60 kN.
           -. Applied shear force : Vuy =        9.08 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.500 m.
           -. Acv    = Bw*d     =    0.180 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      176.59 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      132.44 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.400 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   26,  POS = 1/2 )
           -. Applied axial force : Pu  =      216.12 kN.
           -. Applied shear force : Vuz =       41.56 kN.
           -. d      = Hc-do    =    0.460 m.
           -. Bw     = Bc       =    0.400 m.
           -. Acv    = Bw*d     =    0.184 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      178.29 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      133.72 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   16,  POS = 1/2 )
           -. Applied axial force : Pu  =      265.12 kN.
           -. Applied shear force : Vuy =        9.08 kN.
           -. d      = Bc-do    =    0.360 m.
           -. Bw     = Hc       =    0.500 m.
           -. Acv    = Bw*d     =    0.180 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =      177.25 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =      132.94 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.
```

PROJECT TITLE : Acueducto Agua Bonita San José del Guaviare

MIDAS	**Company**	Leandro Castellanos	**Client**	
	Author	Leandro Castellanos	**File Name**	Tanque Elevado.rcs

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------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                   Gen 2022
==========================================================================================


       +==============================================================+
       |  MIDAS(Modeling, Integrated Design & Analysis Software)      |
       |  midas Gen - Design & checking system for windows            |
       +==============================================================+
       |  RC-Member(Beam/Column/Brace/Wall) Analysis and Design       |
       |  Based On  Eurocode2:04, Eurocode2, ACI318-19,               |
       |            ACI318M-19, ACI318-14, ACI318M-14, ACI318-11,     |
       |            ACI318-08, ACI318-05, ACI318-02, ACI318-99,       |
       |            ACI318-95, ACI318-89, NSR-10, CSA-A23.3-94,       |
       |            BS8110-97, NSCP 2015                              |
       |                                              (c)SINCE 1989   |
       +==============================================================+
       |  MIDAS Information Technology Co.,Ltd.         (MIDAS IT)    |
       |  MIDAS IT Design Development Team                            |
       +==============================================================+
       |            HomePage : www.MidasUser.com                      |
       +==============================================================+
       |  Gen 2022                                                    |
       +==============================================================+


    *. DEFINITION OF LOAD COMBINATIONS WITH SCALING UP FACTORS.
--------------------------------------------------------------------------------------
     LCB  C    Loadcase Name(Factor) + Loadcase Name(Factor) + Loadcase Name(Factor)
--------------------------------------------------------------------------------------
      12  1               D( 1.400) +          Fh( 1.400) +           Fv( 1.400)
      13  1               D( 1.200) +       SRSS11( 1.000) +          Fh( 1.000)
            +               Fv( 1.000) +          Fhi_v( 1.000) +          Fi_v( 1.000)
      14  1               D( 1.200) +       SRSS11(-1.000) +          Fh( 1.000)
            +               Fv( 1.000) +          Fhi_v( 1.000) +          Fi_v( 1.000)
      15  1               D( 1.200) +        SRSS7( 1.000) +          Fh( 1.000)
            +               Fv( 1.000) +          Fhi_v( 1.000) +          Fi_v( 1.000)
      16  1               D( 1.200) +        SRSS8( 1.000) +          Fh( 1.000)
            +               Fv( 1.000) +          Fhi_v( 1.000) +          Fi_v( 1.000)
      17  1               D( 1.200) +        SRSS9( 1.000) +          Fh( 1.000)
            +               Fv( 1.000) +          Fhi_v( 1.000) +          Fi_v( 1.000)
      18  1               D( 1.200) +       SRSS10( 1.000) +          Fh( 1.000)
            +               Fv( 1.000) +          Fhi_v( 1.000) +          Fi_v( 1.000)
      19  1               D( 1.200) +        SRSS7(-1.000) +          Fh( 1.000)
            +               Fv( 1.000) +          Fhi_v( 1.000) +          Fi_v( 1.000)
      20  1               D( 1.200) +        SRSS8(-1.000) +          Fh( 1.000)
            +               Fv( 1.000) +          Fhi_v( 1.000) +          Fi_v( 1.000)
      21  1               D( 1.200) +        SRSS9(-1.000) +          Fh( 1.000)
            +               Fv( 1.000) +          Fhi_v( 1.000) +          Fi_v( 1.000)
      22  1               D( 1.200) +       SRSS10(-1.000) +          Fh( 1.000)
            +               Fv( 1.000) +          Fhi_v( 1.000) +          Fi_v( 1.000)
      23  1               D( 0.900) +       SRSS11( 1.000) +          Fh( 1.000)
            +               Fv( 1.000) +          Fhi_v( 1.000) +          Fi_v( 1.000)
      24  1               D( 0.900) +       SRSS11(-1.000) +          Fh( 1.000)
```

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-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                    Gen 2022
=========================================================================================

           +          Fv( 1.000) +        Fhi_v( 1.000) +        Fi_v( 1.000)
     25  1          D( 0.900) +         Fh( 1.000) +          Fv( 1.000)
           +       Fhi_v( 1.000) +       Fi_v( 1.000) +       SRSS7( 1.000)
     26  1          D( 0.900) +         Fh( 1.000) +          Fv( 1.000)
           +       Fhi_v( 1.000) +       Fi_v( 1.000) +       SRSS8( 1.000)
     27  1          D( 0.900) +         Fh( 1.000) +          Fv( 1.000)
           +       Fhi_v( 1.000) +       Fi_v( 1.000) +       SRSS9( 1.000)
     28  1          D( 0.900) +         Fh( 1.000) +          Fv( 1.000)
           +       Fhi_v( 1.000) +       Fi_v( 1.000) +      SRSS10( 1.000)
     29  1          D( 0.900) +         Fh( 1.000) +          Fv( 1.000)
           +       Fhi_v( 1.000) +       Fi_v( 1.000) +       SRSS7(-1.000)
     30  1          D( 0.900) +         Fh( 1.000) +          Fv( 1.000)
           +       Fhi_v( 1.000) +       Fi_v( 1.000) +       SRSS8(-1.000)
     31  1          D( 0.900) +         Fh( 1.000) +          Fv( 1.000)
           +       Fhi_v( 1.000) +       Fi_v( 1.000) +       SRSS9(-1.000)
     32  1          D( 0.900) +         Fh( 1.000) +          Fv( 1.000)
           +       Fhi_v( 1.000) +       Fi_v( 1.000) +      SRSS10(-1.000)
     33  2          D( 1.000) +         Fh( 1.000) +          Fv( 1.000)
     34  2          D( 1.000) +         Fh( 1.000) +          Fv( 1.000)
           +      SRSS11( 0.700) +      Fhi_v( 1.000) +        Fi_v( 1.000)
     35  2          D( 1.000) +         Fh( 1.000) +          Fv( 1.000)
           +       Fhi_v( 1.000) +       Fi_v( 1.000) +      SRSS11(-0.700)
     36  2          D( 1.000) +         Fh( 1.000) +          Fv( 1.000)
           +       Fhi_v( 1.000) +       Fi_v( 1.000) +       SRSS7( 0.700)
     37  2          D( 1.000) +         Fh( 1.000) +          Fv( 1.000)
           +       Fhi_v( 1.000) +       Fi_v( 1.000) +       SRSS8( 0.700)
     38  2          D( 1.000) +         Fh( 1.000) +          Fv( 1.000)
           +       Fhi_v( 1.000) +       Fi_v( 1.000) +       SRSS9( 0.700)
     39  2          D( 1.000) +         Fh( 1.000) +          Fv( 1.000)
           +       Fhi_v( 1.000) +       Fi_v( 1.000) +      SRSS10( 0.700)
     40  2          D( 1.000) +         Fh( 1.000) +          Fv( 1.000)
           +       Fhi_v( 1.000) +       Fi_v( 1.000) +       SRSS7(-0.700)
     41  2          D( 1.000) +         Fh( 1.000) +          Fv( 1.000)
           +       Fhi_v( 1.000) +       Fi_v( 1.000) +       SRSS8(-0.700)
     42  2          D( 1.000) +         Fh( 1.000) +          Fv( 1.000)
           +       Fhi_v( 1.000) +       Fi_v( 1.000) +       SRSS9(-0.700)
     43  2          D( 1.000) +         Fh( 1.000) +          Fv( 1.000)
           +       Fhi_v( 1.000) +       Fi_v( 1.000) +      SRSS10(-0.700)
     44  2          D( 1.000) +         Fh( 1.000) +          Fv( 1.000)
           +       Fhi_v( 1.000) +       Fi_v( 1.000) +      SRSS11( 0.525)
     45  2          D( 1.000) +         Fh( 1.000) +          Fv( 1.000)
           +       Fhi_v( 1.000) +       Fi_v( 1.000) +      SRSS11(-0.525)
     46  2          D( 1.000) +         Fh( 1.000) +          Fv( 1.000)
           +       Fhi_v( 1.000) +       Fi_v( 1.000) +       SRSS7( 0.525)
     47  2          D( 1.000) +         Fh( 1.000) +          Fv( 1.000)
           +       Fhi_v( 1.000) +       Fi_v( 1.000) +       SRSS8( 0.525)
     48  2          D( 1.000) +         Fh( 1.000) +          Fv( 1.000)
           +       Fhi_v( 1.000) +       Fi_v( 1.000) +       SRSS9( 0.525)
     49  2          D( 1.000) +         Fh( 1.000) +          Fv( 1.000)
           +       Fhi_v( 1.000) +       Fi_v( 1.000) +      SRSS10( 0.525)
     50  2          D( 1.000) +         Fh( 1.000) +          Fv( 1.000)
           +       Fhi_v( 1.000) +       Fi_v( 1.000) +       SRSS7(-0.525)
```

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--------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                         Gen 2022
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      51  2                D( 1.000) +           Fh( 1.000) +            Fv( 1.000)
            +            Fhi_v( 1.000) +          Fi_v( 1.000) +         SRSS8(-0.525)
      52  2                D( 1.000) +           Fh( 1.000) +            Fv( 1.000)
            +            Fhi_v( 1.000) +          Fi_v( 1.000) +         SRSS9(-0.525)
      53  2                D( 1.000) +           Fh( 1.000) +            Fv( 1.000)
            +            Fhi_v( 1.000) +          Fi_v( 1.000) +        SRSS10(-0.525)
      54  2                D( 0.600) +        Fhi_v( 1.000) +          Fi_v( 1.000)
            +           SRSS11( 0.700)
      55  2                D( 0.600) +        Fhi_v( 1.000) +          Fi_v( 1.000)
            +           SRSS11(-0.700)
      56  2                D( 0.600) +        Fhi_v( 1.000) +          Fi_v( 1.000)
            +            SRSS7( 0.700)
      57  2                D( 0.600) +        Fhi_v( 1.000) +          Fi_v( 1.000)
            +            SRSS8( 0.700)
      58  2                D( 0.600) +        Fhi_v( 1.000) +          Fi_v( 1.000)
            +            SRSS9( 0.700)
      59  2                D( 0.600) +        Fhi_v( 1.000) +          Fi_v( 1.000)
            +           SRSS10( 0.700)
      60  2                D( 0.600) +        Fhi_v( 1.000) +          Fi_v( 1.000)
            +            SRSS7(-0.700)
      61  2                D( 0.600) +        Fhi_v( 1.000) +          Fi_v( 1.000)
            +            SRSS8(-0.700)
      62  2                D( 0.600) +        Fhi_v( 1.000) +          Fi_v( 1.000)
            +            SRSS9(-0.700)
      63  2                D( 0.600) +        Fhi_v( 1.000) +          Fi_v( 1.000)
            +           SRSS10(-0.700)
----------------------------------------------------------------------------------------
```

PROJECT TITLE : Acueducto Agua Bonita San José del Guaviare

	Company	Leandro Castellanos	Client	
	Author	Leandro Castellanos	File Name	Tanque Elevado.rcs

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-------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                   Gen 2022
===========================================================================================

      *.midas Gen - RC-BEAM Analysis/Design Program.

      *.PROJECT        : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE    : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER         : Member Type = BEAM,   MEMB =    13

      *.DESCRIPTION OF BEAM DATA (iSEC =     3) : V40*40
        Section Type : Rectangle (RECT)
        Beam Length (Span)          =         2.950 m.
        Section Depth (Hc)          =         0.400 m.
        Section Width (Bc)          =         0.400 m.
        Concrete Strength (fc)      =     28000.000 KPa.
        Modulus of Elasticity (Ec)  =  24870062.324 KPa.
        Main Rebar Strength (fy)    =    420000.000 KPa.
        Stirrups Strength (fys)     =    420000.000 KPa.
        Modulus of Elasticity (Es)  = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

      *.FORCES AND MOMENTS AT CHECK POINT <I> :
        Positive Bending Moment   P-Mu =       18.20 kN-m.,  LCB =  15
        Negative Bending Moment   N-Mu =        9.93 kN-m.,  LCB =  29
        Shear Force                Vu  =       51.81 kN.  ,  LCB =  19

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------
           Location    i     di( m.)       Rebar    Asi( m^2.)
        ---------------------------------------------------------
           Top         1      0.040         3-#4      0.00039
           Bottom      2      0.360         3-#4      0.00039
        ---------------------------------------------------------
           Stirrups : #3

 ===============================================================================
    [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ===============================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500  ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.160 m. < smax  --->  O.K.
```

PROJECT TITLE : Acueducto Agua Bonita San José del Guaviare

MIDAS	**Company**	Leandro Castellanos	**Client**	
	Author	Leandro Castellanos	**File Name**	Tanque Elevado.rcs

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-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
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      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0012
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0012
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0027
           -. Rhomin < Rho < Rhomax  --->  O.K !

      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.017 m.
           -. Mn     = As*fy*(d-a/2)      =       57.14 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       51.43 kN-m.

      ( ). Check ratio of positive moment capacity.
           -. Rat_P  = Mu/phiMn =    0.354  <  1.000  --->  O.K.

 ===================================================================================
    [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
 ===================================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500  ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy              =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.160 m. < smax  --->  O.K.

      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0007
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0007
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0027
           -. Rhomin < Rho < Rhomax  --->  O.K !
```

```
--------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                Gen 2022
======================================================================================


      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.017 m.
           -. Mn     = As*fy*(d-a/2)      =       57.14 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       51.43 kN-m.

      ( ). Check ratio of negative moment capacity.
           -. Rat_N  = Mu/phiMn =    0.193  <  1.000  --->  O.K.

 ================================================================================
    [[[*]]]   CALCULATE DATA OF SPECIAL PROVISIONS FOR SEISMIC DESIGN.
 ================================================================================

      ( ). Design parameters.
           -. fy  = 420000.00000 KPa.
           -. phi    = 1.0

      ( ). Calculate bending strength for design shear force(I, Clockwise)
           -. Ast    =      0.0004 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0171 m.
           -. Mn.I+ = Ast*fy*(d-a/2)  =       57.141 kN-m.

      ( ). Calculate bending strength for design shear force(J, Clockwise)
           -. Ast    =      0.0004 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0171 m.
           -. Mn.J- = Ast*fy*(d-a/2)  =       57.141 kN-m.

      ( ). Calculate bending strength for design shear force(I, Counter-Clockwise)
           -. Ast    =      0.0004 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0171 m.
           -. Mn.I- = Ast*fy*(d-a/2)  =       57.141 kN-m.

      ( ). Calculate bending strength for design shear force(J, Counter-Clockwise)
           -. Ast    =      0.0004 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0171 m.
           -. Mn.J+ = Ast*fy*(d-a/2)  =       57.141 kN-m.

      ( ). Calculate design shear force according to special provisions for seismic design.
           -. Alpha1  = 1.0000
           -. Span    =      2.9500 m.
           -. VzG     =      -7.180 kN.  (by Gravity-Direction Load).
```

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------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                 Gen 2022
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           -. Clockwise
              Ve11_CW = VzG + Alpha1*(Mn.I+ + Mn.J-)/Span =      31.559 kN.
              Ve12_CW = VzG - Alpha1*(Mn.I+ + Mn.J-)/Span =     -45.920 kN.
              Ve1_CW  = MAX[ |Ve11_CW|, |Ve12_CW| ] =      45.920 kN.
           -. Counter-Clockwise
              Ve11_CCW= VzG + Alpha1*(Mn.I- + Mn.J+)/Span =      31.559 kN.
              Ve12_CCW= VzG - Alpha1*(Mn.I- + Mn.J+)/Span =     -45.920 kN.
              Ve1_CCW = MAX[ |Ve11_CCW|, |Ve12_CCW| ] =      45.920 kN.

           -. Ve1     = MAX[ |Ve1_CW|, |Ve1_CCW| ]  =      45.920 kN.
           -. VzOrg   =     -51.814 kN.  (by Analysis).
           -. Ve2     =      51.814 kN.  (by Applied Alpha2).
           -.   Vu    = MAX[ |VzOrg|, MIN(|Ve2|,Ve1) ]  =      51.814 kN.

 ================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY.
 ================================================================================

      ( ). Compute shear strength of concrete.
           -. Vu     =       51.81 kN.
           -. Vc     = 0.17*SQRT(fc)*bw*d =      129.54 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc             =       97.15 kN.
           -. phiVc/2 < Vu < phiVc  --->  Minimum shear reinforcement is required.

      ( ). Compute required shear reinforcement. ( Av1 =  0.00007 m^2. )
           -. Avmin1 = 0.35*bw/fys           =3.333e-04 m^2/m.
           -. Avmin2 = 0.062*SQRT(fc)*bw/fys =3.125e-04 m^2/m.
           -. Av     = MAX[ Avmin1, Avmin2 ] =3.333e-04 m^2/m.
           -. N_leg  =  2
           -. Calculate spacing s1 = N_leg*Av1 / Av         =    0.426 m.
           -. Applied spacing s    = MIN[ s1, d/2, 600 mm ] =    0.180 m.
```

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-------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                 Gen 2022
===========================================================================================

      *.midas Gen - RC-BEAM Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = BEAM,   MEMB =    14

      *.DESCRIPTION OF BEAM DATA (iSEC =     3) : V40*40
        Section Type : Rectangle (RECT)
        Beam Length (Span)            =         2.950 m.
        Section Depth (Hc)            =         0.400 m.
        Section Width (Bc)            =         0.400 m.
        Concrete Strength (fc)        =     28000.000 KPa.
        Modulus of Elasticity (Ec)    =  24870062.324 KPa.
        Main Rebar Strength (fy)      =    420000.000 KPa.
        Stirrups Strength (fys)       =    420000.000 KPa.
        Modulus of Elasticity (Es)    = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

      *.FORCES AND MOMENTS AT CHECK POINT <I> :
        Positive Bending Moment   P-Mu =       18.25 kN-m.,  LCB =  15
        Negative Bending Moment   N-Mu =        9.87 kN-m.,  LCB =  29
        Shear Force                Vu  =       51.64 kN.  ,  LCB =  19

      *.REINFORCEMENT PATTERN :
        --------------------------------------------------------
           Location    i     di( m.)       Rebar    Asi( m^2.)
        --------------------------------------------------------
           Top         1      0.040         3-#4      0.00039
           Bottom      2      0.360         3-#4      0.00039
        --------------------------------------------------------
           Stirrups : #3

 ===============================================================================
    [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ===============================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.160 m. < smax  --->  O.K.
```

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--------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
============================================================================================


     ( ). Compute required ratio of reinforcement.
          -. k      = 1.000000
          -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
          -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0013
          -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0013
          -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
          -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

     ( ). Check ratio of tensile reinforcement.
          -. Rho = As/(bw*d) =   0.0027
          -. Rhomin < Rho < Rhomax  --->  O.K !

     ( ). Compute moment capacity.
          -. a      = As*fy/(0.85*fc*bw) =    0.017 m.
          -. Mn     = As*fy*(d-a/2)      =       57.14 kN-m.
          -. phi    = 0.90
          -. phiMn  = phi*Mn             =       51.43 kN-m.

     ( ). Check ratio of positive moment capacity.
          -. Rat_P  = Mu/phiMn =    0.355  <  1.000  --->  O.K.

 ================================================================================
    [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
 ================================================================================

     ( ). Compute design parameter.
          -. beta1  = 0.8500   ( fc < 28 MPa.)

     ( ). Check spacing of reinforcement closet to the tensile face.
          -. fs   = (2/3)*fy             =2.800e+05 KPa.
          -. cc   =    0.034 m.
          -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
          -. s2   = 300*(280/fs)         =    0.300 m.
          -. smax = MIN[ s1, s2 ]        =    0.296 m.
          -. s    =    0.160 m. < smax  --->  O.K.

     ( ). Compute required ratio of reinforcement.
          -. k      = 1.000000
          -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
          -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0007
          -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0007
          -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
          -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

     ( ). Check ratio of tensile reinforcement.
          -. Rho = As/(bw*d) =   0.0027
          -. Rhomin < Rho < Rhomax  --->  O.K !
```

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-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
=========================================================================================


      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.017 m.
           -. Mn     = As*fy*(d-a/2)      =       57.14 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       51.43 kN-m.

      ( ). Check ratio of negative moment capacity.
           -. Rat_N  = Mu/phiMn =    0.192  <  1.000  --->  O.K.

 ================================================================================
    [[[*]]]   CALCULATE DATA OF SPECIAL PROVISIONS FOR SEISMIC DESIGN.
 ================================================================================

      ( ). Design parameters.
           -. fy  = 420000.00000 KPa.
           -. phi    = 1.0

      ( ). Calculate bending strength for design shear force(I, Clockwise)
           -. Ast    =      0.0004 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0171 m.
           -. Mn.I+ = Ast*fy*(d-a/2)  =       57.141 kN-m.

      ( ). Calculate bending strength for design shear force(J, Clockwise)
           -. Ast    =      0.0004 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0171 m.
           -. Mn.J- = Ast*fy*(d-a/2)  =       57.141 kN-m.

      ( ). Calculate bending strength for design shear force(I, Counter-Clockwise)
           -. Ast    =      0.0004 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0171 m.
           -. Mn.I- = Ast*fy*(d-a/2)  =       57.141 kN-m.

      ( ). Calculate bending strength for design shear force(J, Counter-Clockwise)
           -. Ast    =      0.0004 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0171 m.
           -. Mn.J+ = Ast*fy*(d-a/2)  =       57.141 kN-m.

      ( ). Calculate design shear force according to special provisions for seismic design.
           -. Alpha1  = 1.0000
           -. Span    =      2.9500 m.
           -. VzG     =      -6.983 kN.  (by Gravity-Direction Load).
```

```
-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                 Gen 2022
=========================================================================================

           -. Clockwise
              Ve11_CW = VzG + Alpha1*(Mn.I+ + Mn.J-)/Span =      31.756 kN.
              Ve12_CW = VzG - Alpha1*(Mn.I+ + Mn.J-)/Span =     -45.723 kN.
              Ve1_CW  = MAX[ |Ve11_CW|, |Ve12_CW| ] =      45.723 kN.
           -. Counter-Clockwise
              Ve11_CCW= VzG + Alpha1*(Mn.I- + Mn.J+)/Span =      31.756 kN.
              Ve12_CCW= VzG - Alpha1*(Mn.I- + Mn.J+)/Span =     -45.723 kN.
              Ve1_CCW = MAX[ |Ve11_CCW|, |Ve12_CCW| ] =      45.723 kN.

           -. Ve1     = MAX[ |Ve1_CW|, |Ve1_CCW| ]  =      45.723 kN.
           -. VzOrg   =     -51.638 kN.  (by Analysis).
           -. Ve2     =      51.638 kN.  (by Applied Alpha2).
           -.   Vu    = MAX[ |VzOrg|, MIN(|Ve2|,Ve1) ]  =      51.638 kN.

 ===============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY.
 ===============================================================================

      ( ). Compute shear strength of concrete.
           -. Vu     =       51.64 kN.
           -. Vc     = 0.17*SQRT(fc)*bw*d =      129.54 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc             =       97.15 kN.
           -. phiVc/2 < Vu < phiVc  --->  Minimum shear reinforcement is required.

      ( ). Compute required shear reinforcement. ( Av1 =  0.00007 m^2. )
           -. Avmin1 = 0.35*bw/fys           =3.333e-04 m^2/m.
           -. Avmin2 = 0.062*SQRT(fc)*bw/fys =3.125e-04 m^2/m.
           -. Av     = MAX[ Avmin1, Avmin2 ] =3.333e-04 m^2/m.
           -. N_leg  =  2
           -. Calculate spacing s1 = N_leg*Av1 / Av         =    0.426 m.
           -. Applied spacing s    = MIN[ s1, d/2, 600 mm ] =    0.180 m.
```

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-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
=========================================================================================

      *.midas Gen - RC-BEAM Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = BEAM,   MEMB =    15

      *.DESCRIPTION OF BEAM DATA (iSEC =     3) : V40*40
        Section Type : Rectangle (RECT)
        Beam Length (Span)            =         2.950 m.
        Section Depth (Hc)            =         0.400 m.
        Section Width (Bc)            =         0.400 m.
        Concrete Strength (fc)        =     28000.000 KPa.
        Modulus of Elasticity (Ec)    =  24870062.324 KPa.
        Main Rebar Strength (fy)      =    420000.000 KPa.
        Stirrups Strength (fys)       =    420000.000 KPa.
        Modulus of Elasticity (Es)    = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

      *.FORCES AND MOMENTS AT CHECK POINT <I> :
        Positive Bending Moment   P-Mu =       18.26 kN-m.,  LCB =  15
        Negative Bending Moment   N-Mu =        9.77 kN-m.,  LCB =  29
        Shear Force                Vu  =       51.19 kN.  ,  LCB =  19

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------
           Location    i     di( m.)       Rebar    Asi( m^2.)
        ---------------------------------------------------------
           Top         1      0.040         3-#4      0.00039
           Bottom      2      0.360         3-#4      0.00039
        ---------------------------------------------------------
           Stirrups : #3

 ===============================================================================
    [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ===============================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.160 m. < smax  --->  O.K.
```

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-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
=========================================================================================


      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0013
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0013
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0027
           -. Rhomin < Rho < Rhomax  --->  O.K !

      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.017 m.
           -. Mn     = As*fy*(d-a/2)      =       57.14 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       51.43 kN-m.

      ( ). Check ratio of positive moment capacity.
           -. Rat_P  = Mu/phiMn =    0.355  <  1.000  --->  O.K.

 ===============================================================================
    [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
 ===============================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500  ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.160 m. < smax  --->  O.K.

      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0007
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0007
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0027
           -. Rhomin < Rho < Rhomax  --->  O.K !
```

```
-------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                   Gen 2022
===========================================================================================


      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.017 m.
           -. Mn     = As*fy*(d-a/2)      =       57.14 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       51.43 kN-m.

      ( ). Check ratio of negative moment capacity.
           -. Rat_N  = Mu/phiMn =    0.190  <  1.000  --->  O.K.

 ================================================================================
    [[[*]]]   CALCULATE DATA OF SPECIAL PROVISIONS FOR SEISMIC DESIGN.
 ================================================================================

      ( ). Design parameters.
           -. fy  = 420000.00000 KPa.
           -. phi    = 1.0

      ( ). Calculate bending strength for design shear force(I, Clockwise)
           -. Ast    =      0.0004 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0171 m.
           -. Mn.I+ = Ast*fy*(d-a/2)  =       57.141 kN-m.

      ( ). Calculate bending strength for design shear force(J, Clockwise)
           -. Ast    =      0.0004 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0171 m.
           -. Mn.J- = Ast*fy*(d-a/2)  =       57.141 kN-m.

      ( ). Calculate bending strength for design shear force(I, Counter-Clockwise)
           -. Ast    =      0.0004 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0171 m.
           -. Mn.I- = Ast*fy*(d-a/2)  =       57.141 kN-m.

      ( ). Calculate bending strength for design shear force(J, Counter-Clockwise)
           -. Ast    =      0.0004 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0171 m.
           -. Mn.J+ = Ast*fy*(d-a/2)  =       57.141 kN-m.

      ( ). Calculate design shear force according to special provisions for seismic design.
           -. Alpha1  = 1.0000
           -. Span    =      2.9500 m.
           -. VzG     =      -6.844 kN.  (by Gravity-Direction Load).
```

```
-------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                 Gen 2022
===========================================================================================

          -. Clockwise
             Ve11_CW = VzG + Alpha1*(Mn.I+ + Mn.J-)/Span =      31.896 kN.
             Ve12_CW = VzG - Alpha1*(Mn.I+ + Mn.J-)/Span =     -45.583 kN.
             Ve1_CW  = MAX[ |Ve11_CW|, |Ve12_CW| ] =      45.583 kN.
          -. Counter-Clockwise
             Ve11_CCW= VzG + Alpha1*(Mn.I- + Mn.J+)/Span =      31.896 kN.
             Ve12_CCW= VzG - Alpha1*(Mn.I- + Mn.J+)/Span =     -45.583 kN.
             Ve1_CCW = MAX[ |Ve11_CCW|, |Ve12_CCW| ] =      45.583 kN.

          -. Ve1     = MAX[ |Ve1_CW|, |Ve1_CCW| ]  =      45.583 kN.
          -. VzOrg   =     -51.189 kN.  (by Analysis).
          -. Ve2     =      51.189 kN.  (by Applied Alpha2).
          -.   Vu    = MAX[ |VzOrg|, MIN(|Ve2|,Ve1) ]  =      51.189 kN.

 ================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY.
 ================================================================================

      ( ). Compute shear strength of concrete.
          -. Vu     =       51.19 kN.
          -. Vc     = 0.17*SQRT(fc)*bw*d =      129.54 kN.
          -. phi    = 0.75
          -. phiVc  = phi*Vc             =       97.15 kN.
          -. phiVc/2 < Vu < phiVc  --->  Minimum shear reinforcement is required.

      ( ). Compute required shear reinforcement. ( Av1 =  0.00007 m^2. )
          -. Avmin1 = 0.35*bw/fys           =3.333e-04 m^2/m.
          -. Avmin2 = 0.062*SQRT(fc)*bw/fys =3.125e-04 m^2/m.
          -. Av     = MAX[ Avmin1, Avmin2 ] =3.333e-04 m^2/m.
          -. N_leg  =  2
          -. Calculate spacing s1 = N_leg*Av1 / Av         =    0.426 m.
          -. Applied spacing s    = MIN[ s1, d/2, 600 mm ] =    0.180 m.
```

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--------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                 Gen 2022
============================================================================================

      *.midas Gen - RC-BEAM Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = BEAM,   MEMB =    16

      *.DESCRIPTION OF BEAM DATA (iSEC =     3) : V40*40
        Section Type : Rectangle (RECT)
        Beam Length (Span)            =         2.950 m.
        Section Depth (Hc)            =         0.400 m.
        Section Width (Bc)            =         0.400 m.
        Concrete Strength (fc)        =     28000.000 KPa.
        Modulus of Elasticity (Ec)    =  24870062.324 KPa.
        Main Rebar Strength (fy)      =    420000.000 KPa.
        Stirrups Strength (fys)       =    420000.000 KPa.
        Modulus of Elasticity (Es)    = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

      *.FORCES AND MOMENTS AT CHECK POINT <I> :
        Positive Bending Moment   P-Mu =       18.23 kN-m.,  LCB =  15
        Negative Bending Moment   N-Mu =        9.82 kN-m.,  LCB =  29
        Shear Force                Vu  =       51.31 kN.  ,  LCB =  19

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------
           Location    i     di( m.)       Rebar    Asi( m^2.)
        ---------------------------------------------------------
           Top         1      0.040         3-#4      0.00039
           Bottom      2      0.360         3-#4      0.00039
        ---------------------------------------------------------
           Stirrups : #3

 ================================================================================
    [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ================================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.160 m. < smax  --->  O.K.
```

```
--------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
============================================================================================


      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0013
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0013
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0027
           -. Rhomin < Rho < Rhomax  --->  O.K !

      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.017 m.
           -. Mn     = As*fy*(d-a/2)      =       57.14 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       51.43 kN-m.

      ( ). Check ratio of positive moment capacity.
           -. Rat_P  = Mu/phiMn =    0.354  <  1.000  --->  O.K.

 ==================================================================================
    [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
 ==================================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500  ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.160 m. < smax  --->  O.K.

      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0007
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0007
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0027
           -. Rhomin < Rho < Rhomax  --->  O.K !
```

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--------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                Gen 2022
======================================================================================


      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.017 m.
           -. Mn     = As*fy*(d-a/2)      =       57.14 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       51.43 kN-m.

      ( ). Check ratio of negative moment capacity.
           -. Rat_N  = Mu/phiMn =    0.191  <  1.000  --->  O.K.

 ===============================================================================
    [[[*]]]   CALCULATE DATA OF SPECIAL PROVISIONS FOR SEISMIC DESIGN.
 ===============================================================================

      ( ). Design parameters.
           -. fy  = 420000.00000 KPa.
           -. phi    = 1.0

      ( ). Calculate bending strength for design shear force(I, Clockwise)
           -. Ast    =      0.0004 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0171 m.
           -. Mn.I+ = Ast*fy*(d-a/2)  =       57.141 kN-m.

      ( ). Calculate bending strength for design shear force(J, Clockwise)
           -. Ast    =      0.0004 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0171 m.
           -. Mn.J- = Ast*fy*(d-a/2)  =       57.141 kN-m.

      ( ). Calculate bending strength for design shear force(I, Counter-Clockwise)
           -. Ast    =      0.0004 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0171 m.
           -. Mn.I- = Ast*fy*(d-a/2)  =       57.141 kN-m.

      ( ). Calculate bending strength for design shear force(J, Counter-Clockwise)
           -. Ast    =      0.0004 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0171 m.
           -. Mn.J+ = Ast*fy*(d-a/2)  =       57.141 kN-m.

      ( ). Calculate design shear force according to special provisions for seismic design.
           -. Alpha1  = 1.0000
           -. Span    =      2.9500 m.
           -. VzG     =      -6.983 kN.  (by Gravity-Direction Load).
```

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------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                 Gen 2022
==========================================================================================

           -. Clockwise
              Ve11_CW = VzG + Alpha1*(Mn.I+ + Mn.J-)/Span =      31.757 kN.
              Ve12_CW = VzG - Alpha1*(Mn.I+ + Mn.J-)/Span =     -45.722 kN.
              Ve1_CW  = MAX[ |Ve11_CW|, |Ve12_CW| ] =      45.722 kN.
           -. Counter-Clockwise
              Ve11_CCW= VzG + Alpha1*(Mn.I- + Mn.J+)/Span =      31.757 kN.
              Ve12_CCW= VzG - Alpha1*(Mn.I- + Mn.J+)/Span =     -45.722 kN.
              Ve1_CCW = MAX[ |Ve11_CCW|, |Ve12_CCW| ] =      45.722 kN.

           -. Ve1     = MAX[ |Ve1_CW|, |Ve1_CCW| ]  =      45.722 kN.
           -. VzOrg   =     -51.312 kN.  (by Analysis).
           -. Ve2     =      51.312 kN.  (by Applied Alpha2).
           -.   Vu    = MAX[ |VzOrg|, MIN(|Ve2|,Ve1) ]  =      51.312 kN.

 ===============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY.
 ===============================================================================

      ( ). Compute shear strength of concrete.
           -. Vu     =       51.31 kN.
           -. Vc     = 0.17*SQRT(fc)*bw*d =      129.54 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc             =       97.15 kN.
           -. phiVc/2 < Vu < phiVc  --->  Minimum shear reinforcement is required.

      ( ). Compute required shear reinforcement. ( Av1 =  0.00007 m^2. )
           -. Avmin1 = 0.35*bw/fys           =3.333e-04 m^2/m.
           -. Avmin2 = 0.062*SQRT(fc)*bw/fys =3.125e-04 m^2/m.
           -. Av     = MAX[ Avmin1, Avmin2 ] =3.333e-04 m^2/m.
           -. N_leg  =  2
           -. Calculate spacing s1 = N_leg*Av1 / Av         =    0.426 m.
           -. Applied spacing s    = MIN[ s1, d/2, 600 mm ] =    0.180 m.
```

```
-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                 Gen 2022
=========================================================================================

      *.midas Gen - RC-BEAM Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = BEAM,   MEMB =    17

      *.DESCRIPTION OF BEAM DATA (iSEC =     2) : V30*40
        Section Type : Rectangle (RECT)
        Beam Length (Span)             =         2.950 m.
        Section Depth (Hc)             =         0.400 m.
        Section Width (Bc)             =         0.300 m.
        Concrete Strength (fc)         =     28000.000 KPa.
        Modulus of Elasticity (Ec)     =  24870062.324 KPa.
        Main Rebar Strength (fy)       =    420000.000 KPa.
        Stirrups Strength (fys)        =    420000.000 KPa.
        Modulus of Elasticity (Es)     = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

      *.FORCES AND MOMENTS AT CHECK POINT <I> :
        Positive Bending Moment   P-Mu =       63.07 kN-m.,  LCB =  25
        Negative Bending Moment   N-Mu =       68.30 kN-m.,  LCB =  19
        Shear Force                Vu  =       57.05 kN.  ,  LCB =  19

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------
           Location    i     di( m.)       Rebar    Asi( m^2.)
        ---------------------------------------------------------
           Top         1      0.040         2-#6      0.00057
           Bottom      2      0.360         4-#4      0.00052
        ---------------------------------------------------------
           Stirrups : #3

 ================================================================================
    [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ================================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500  ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.073 m. < smax  --->  O.K.
```

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---------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                 Gen 2022
=======================================================================================


      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0060
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0048
           -. Rhomin < Rho < Rhomax  --->  O.K !

      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.030 m.
           -. Mn     = As*fy*(d-a/2)      =       74.75 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       67.27 kN-m.

      ( ). Check ratio of positive moment capacity.
           -. Rat_P  = Mu/phiMn =    0.938  <  1.000  --->  O.K.

 ================================================================================
    [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
 ================================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500  ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.030 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.304 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.300 m.
           -. s    =    0.220 m. < smax  --->  O.K.

      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0065
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0053
           -. Rhomin < Rho < Rhomax  --->  O.K !
```

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-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                   Gen 2022
=========================================================================================


      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.033 m.
           -. Mn     = As*fy*(d-a/2)      =       81.86 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       73.67 kN-m.

      ( ). Check ratio of negative moment capacity.
           -. Rat_N  = Mu/phiMn =    0.927  <  1.000  --->  O.K.

 ===============================================================================
    [[[*]]]   CALCULATE DATA OF SPECIAL PROVISIONS FOR SEISMIC DESIGN.
 ===============================================================================

      ( ). Design parameters.
           -. fy  = 420000.00000 KPa.
           -. phi    = 1.0

      ( ). Calculate bending strength for design shear force(I, Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.I+ = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate bending strength for design shear force(J, Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.J- = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate bending strength for design shear force(I, Counter-Clockwise)
           -. Ast    =      0.0006 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0334 m.
           -. Mn.I- = Ast*fy*(d-a/2)  =       81.861 kN-m.

      ( ). Calculate bending strength for design shear force(J, Counter-Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.J+ = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate design shear force according to special provisions for seismic design.
           -. Alpha1  = 1.0000
           -. Span    =      2.5000 m.(Net Length)
           -. VzG     =      -4.423 kN.  (by Gravity-Direction Load).
```

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------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
==========================================================================================

           -. Clockwise
              Ve11_CW = VzG + Alpha1*(Mn.I+ + Mn.J-)/Span =      55.376 kN.
              Ve12_CW = VzG - Alpha1*(Mn.I+ + Mn.J-)/Span =     -64.221 kN.
              Ve1_CW  = MAX[ |Ve11_CW|, |Ve12_CW| ] =      64.221 kN.
           -. Counter-Clockwise
              Ve11_CCW= VzG + Alpha1*(Mn.I- + Mn.J+)/Span =      58.221 kN.
              Ve12_CCW= VzG - Alpha1*(Mn.I- + Mn.J+)/Span =     -67.066 kN.
              Ve1_CCW = MAX[ |Ve11_CCW|, |Ve12_CCW| ] =      67.066 kN.

           -. Ve1     = MAX[ |Ve1_CW|, |Ve1_CCW| ]  =      67.066 kN.
           -. VzOrg   =     -57.049 kN.  (by Analysis).
           -. Ve2     =      57.049 kN.  (by Applied Alpha2).
           -.   Vu    = MAX[ |VzOrg|, MIN(|Ve2|,Ve1) ]  =      57.049 kN.

 ===============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY.
 ===============================================================================

      ( ). Compute shear strength of concrete.
           -. Vu      =       57.05 kN.
           -. Vc      = 0.17*SQRT(fc)*bw*d =       97.15 kN.
           -. phi     = 0.75
           -. phiVc   = phi*Vc             =       72.86 kN.
           -. phiVc/2 < Vu < phiVc  --->  Minimum shear reinforcement is required.

      ( ). Compute required shear reinforcement. ( Av1 =  0.00007 m^2. )
           -. Avmin1 = 0.35*bw/fys           =2.500e-04 m^2/m.
           -. Avmin2 = 0.062*SQRT(fc)*bw/fys =2.343e-04 m^2/m.
           -. Av     = MAX[ Avmin1, Avmin2 ] =2.500e-04 m^2/m.
           -. N_leg  =  2
           -. Calculate spacing s1 = N_leg*Av1 / Av         =    0.568 m.
           -. Applied spacing s    = MIN[ s1, d/2, 600 mm ] =    0.180 m.
```

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---------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
=======================================================================================

      *.midas Gen - RC-BEAM Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = BEAM,   MEMB =    18

      *.DESCRIPTION OF BEAM DATA (iSEC =     2) : V30*40
        Section Type : Rectangle (RECT)
        Beam Length (Span)            =         2.950 m.
        Section Depth (Hc)            =         0.400 m.
        Section Width (Bc)            =         0.300 m.
        Concrete Strength (fc)        =     28000.000 KPa.
        Modulus of Elasticity (Ec)    =  24870062.324 KPa.
        Main Rebar Strength (fy)      =    420000.000 KPa.
        Stirrups Strength (fys)       =    420000.000 KPa.
        Modulus of Elasticity (Es)    = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

      *.FORCES AND MOMENTS AT CHECK POINT <I> :
        Positive Bending Moment   P-Mu =       63.09 kN-m.,  LCB =  25
        Negative Bending Moment   N-Mu =       68.30 kN-m.,  LCB =  19
        Shear Force                Vu  =       57.05 kN.  ,  LCB =  19

      *.REINFORCEMENT PATTERN :
        --------------------------------------------------------
           Location    i     di( m.)       Rebar    Asi( m^2.)
        --------------------------------------------------------
           Top         1      0.040         2-#6      0.00057
           Bottom      2      0.360         4-#4      0.00052
        --------------------------------------------------------
           Stirrups : #3

 ===============================================================================
    [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ===============================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500  ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy            =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.073 m. < smax  --->  O.K.
```

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-------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
===========================================================================================


      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0060
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0048
           -. Rhomin < Rho < Rhomax  --->  O.K !

      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.030 m.
           -. Mn     = As*fy*(d-a/2)      =       74.75 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       67.27 kN-m.

      ( ). Check ratio of positive moment capacity.
           -. Rat_P  = Mu/phiMn =    0.938  <  1.000  --->  O.K.

 ===============================================================================
    [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
 ===============================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500  ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.030 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.304 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.300 m.
           -. s    =    0.220 m. < smax  --->  O.K.

      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0065
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0053
           -. Rhomin < Rho < Rhomax  --->  O.K !
```

```
------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
==========================================================================================


      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.033 m.
           -. Mn     = As*fy*(d-a/2)      =       81.86 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       73.67 kN-m.

      ( ). Check ratio of negative moment capacity.
           -. Rat_N  = Mu/phiMn =    0.927  <  1.000  --->  O.K.

 ===============================================================================
    [[[*]]]   CALCULATE DATA OF SPECIAL PROVISIONS FOR SEISMIC DESIGN.
 ===============================================================================

      ( ). Design parameters.
           -. fy  = 420000.00000 KPa.
           -. phi    = 1.0

      ( ). Calculate bending strength for design shear force(I, Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.I+ = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate bending strength for design shear force(J, Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.J- = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate bending strength for design shear force(I, Counter-Clockwise)
           -. Ast    =      0.0006 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0334 m.
           -. Mn.I- = Ast*fy*(d-a/2)  =       81.861 kN-m.

      ( ). Calculate bending strength for design shear force(J, Counter-Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.J+ = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate design shear force according to special provisions for seismic design.
           -. Alpha1  = 1.0000
           -. Span    =      2.5000 m.(Net Length)
           -. VzG     =      -4.404 kN.  (by Gravity-Direction Load).
```

```
------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                 Gen 2022
==========================================================================================

           -. Clockwise
              Ve11_CW = VzG + Alpha1*(Mn.I+ + Mn.J-)/Span =      55.394 kN.
              Ve12_CW = VzG - Alpha1*(Mn.I+ + Mn.J-)/Span =     -64.202 kN.
              Ve1_CW  = MAX[ |Ve11_CW|, |Ve12_CW| ] =      64.202 kN.
           -. Counter-Clockwise
              Ve11_CCW= VzG + Alpha1*(Mn.I- + Mn.J+)/Span =      58.240 kN.
              Ve12_CCW= VzG - Alpha1*(Mn.I- + Mn.J+)/Span =     -67.047 kN.
              Ve1_CCW = MAX[ |Ve11_CCW|, |Ve12_CCW| ] =      67.047 kN.

           -. Ve1     = MAX[ |Ve1_CW|, |Ve1_CCW| ]  =      67.047 kN.
           -. VzOrg   =     -57.051 kN.  (by Analysis).
           -. Ve2     =      57.051 kN.  (by Applied Alpha2).
           -.   Vu    = MAX[ |VzOrg|, MIN(|Ve2|,Ve1) ]  =      57.051 kN.

 ===============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY.
 ===============================================================================

      ( ). Compute shear strength of concrete.
           -. Vu     =       57.05 kN.
           -. Vc     = 0.17*SQRT(fc)*bw*d =       97.15 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc             =       72.86 kN.
           -. phiVc/2 < Vu < phiVc  --->  Minimum shear reinforcement is required.

      ( ). Compute required shear reinforcement. ( Av1 =  0.00007 m^2. )
           -. Avmin1 = 0.35*bw/fys           =2.500e-04 m^2/m.
           -. Avmin2 = 0.062*SQRT(fc)*bw/fys =2.343e-04 m^2/m.
           -. Av     = MAX[ Avmin1, Avmin2 ] =2.500e-04 m^2/m.
           -. N_leg  =  2
           -. Calculate spacing s1 = N_leg*Av1 / Av         =    0.568 m.
           -. Applied spacing s    = MIN[ s1, d/2, 600 mm ] =    0.180 m.
```

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--------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
============================================================================================

      *.midas Gen - RC-BEAM Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = BEAM,   MEMB =    19

      *.DESCRIPTION OF BEAM DATA (iSEC =     2) : V30*40
        Section Type : Rectangle (RECT)
        Beam Length (Span)             =         2.950 m.
        Section Depth (Hc)             =         0.400 m.
        Section Width (Bc)             =         0.300 m.
        Concrete Strength (fc)         =     28000.000 KPa.
        Modulus of Elasticity (Ec)     =  24870062.324 KPa.
        Main Rebar Strength (fy)       =    420000.000 KPa.
        Stirrups Strength (fys)        =    420000.000 KPa.
        Modulus of Elasticity (Es)     = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

      *.FORCES AND MOMENTS AT CHECK POINT <I> :
        Positive Bending Moment   P-Mu =       63.15 kN-m.,  LCB =  25
        Negative Bending Moment   N-Mu =       68.37 kN-m.,  LCB =  19
        Shear Force                Vu  =       57.19 kN.  ,  LCB =  19

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------
           Location    i     di( m.)       Rebar    Asi( m^2.)
        ---------------------------------------------------------
           Top         1      0.040         2-#6      0.00057
           Bottom      2      0.360         4-#4      0.00052
        ---------------------------------------------------------
           Stirrups : #3

 ================================================================================
    [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ================================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.073 m. < smax  --->  O.K.
```

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--------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                    Gen 2022
============================================================================================


      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0060
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0048
           -. Rhomin < Rho < Rhomax  --->  O.K !

      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.030 m.
           -. Mn     = As*fy*(d-a/2)      =       74.75 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       67.27 kN-m.

      ( ). Check ratio of positive moment capacity.
           -. Rat_P  = Mu/phiMn =    0.939  <  1.000  --->  O.K.

 ==================================================================================
    [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
 ==================================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy              =2.800e+05 KPa.
           -. cc   =    0.030 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.304 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.300 m.
           -. s    =    0.220 m. < smax  --->  O.K.

      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0065
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0053
           -. Rhomin < Rho < Rhomax  --->  O.K !
```

```
-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                      Gen 2022
=========================================================================================


      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.033 m.
           -. Mn     = As*fy*(d-a/2)      =       81.86 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       73.67 kN-m.

      ( ). Check ratio of negative moment capacity.
           -. Rat_N  = Mu/phiMn =    0.928  <  1.000  --->  O.K.

 ===============================================================================
    [[[*]]]   CALCULATE DATA OF SPECIAL PROVISIONS FOR SEISMIC DESIGN.
 ===============================================================================

      ( ). Design parameters.
           -. fy  = 420000.00000 KPa.
           -. phi    = 1.0

      ( ). Calculate bending strength for design shear force(I, Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.I+ = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate bending strength for design shear force(J, Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.J- = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate bending strength for design shear force(I, Counter-Clockwise)
           -. Ast    =      0.0006 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0334 m.
           -. Mn.I- = Ast*fy*(d-a/2)  =       81.861 kN-m.

      ( ). Calculate bending strength for design shear force(J, Counter-Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.J+ = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate design shear force according to special provisions for seismic design.
           -. Alpha1  = 1.0000
           -. Span    =      2.5000 m.(Net Length)
           -. VzG     =      -4.443 kN.  (by Gravity-Direction Load).
```

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-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                 Gen 2022
=========================================================================================

           -. Clockwise
              Ve11_CW = VzG + Alpha1*(Mn.I+ + Mn.J-)/Span =      55.356 kN.
              Ve12_CW = VzG - Alpha1*(Mn.I+ + Mn.J-)/Span =     -64.241 kN.
              Ve1_CW  = MAX[ |Ve11_CW|, |Ve12_CW| ] =      64.241 kN.
           -. Counter-Clockwise
              Ve11_CCW= VzG + Alpha1*(Mn.I- + Mn.J+)/Span =      58.201 kN.
              Ve12_CCW= VzG - Alpha1*(Mn.I- + Mn.J+)/Span =     -67.086 kN.
              Ve1_CCW = MAX[ |Ve11_CCW|, |Ve12_CCW| ] =      67.086 kN.

           -. Ve1     = MAX[ |Ve1_CW|, |Ve1_CCW| ]  =      67.086 kN.
           -. VzOrg   =     -57.188 kN.  (by Analysis).
           -. Ve2     =      57.188 kN.  (by Applied Alpha2).
           -.   Vu    = MAX[ |VzOrg|, MIN(|Ve2|,Ve1) ]  =      57.188 kN.

 ===============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY.
 ===============================================================================

      ( ). Compute shear strength of concrete.
           -. Vu     =       57.19 kN.
           -. Vc     = 0.17*SQRT(fc)*bw*d =       97.15 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc             =       72.86 kN.
           -. phiVc/2 < Vu < phiVc  --->  Minimum shear reinforcement is required.

      ( ). Compute required shear reinforcement. ( Av1 =  0.00007 m^2. )
           -. Avmin1 = 0.35*bw/fys           =2.500e-04 m^2/m.
           -. Avmin2 = 0.062*SQRT(fc)*bw/fys =2.343e-04 m^2/m.
           -. Av     = MAX[ Avmin1, Avmin2 ] =2.500e-04 m^2/m.
           -. N_leg  =  2
           -. Calculate spacing s1 = N_leg*Av1 / Av         =    0.568 m.
           -. Applied spacing s    = MIN[ s1, d/2, 600 mm ] =    0.180 m.
```

```
-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
=========================================================================================

      *.midas Gen - RC-BEAM Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = BEAM,   MEMB =    20

      *.DESCRIPTION OF BEAM DATA (iSEC =     2) : V30*40
        Section Type : Rectangle (RECT)
        Beam Length (Span)          =         2.950 m.
        Section Depth (Hc)          =         0.400 m.
        Section Width (Bc)          =         0.300 m.
        Concrete Strength (fc)      =     28000.000 KPa.
        Modulus of Elasticity (Ec)  =  24870062.324 KPa.
        Main Rebar Strength (fy)    =    420000.000 KPa.
        Stirrups Strength (fys)     =    420000.000 KPa.
        Modulus of Elasticity (Es)  = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

      *.FORCES AND MOMENTS AT CHECK POINT <I> :
        Positive Bending Moment   P-Mu =       63.16 kN-m.,  LCB =  25
        Negative Bending Moment   N-Mu =       68.36 kN-m.,  LCB =  19
        Shear Force                Vu  =       57.18 kN.  ,  LCB =  19

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------
           Location    i     di( m.)       Rebar    Asi( m^2.)
        ---------------------------------------------------------
           Top         1      0.040         2-#6      0.00057
           Bottom      2      0.360         4-#4      0.00052
        ---------------------------------------------------------
           Stirrups : #3

 ===============================================================================
    [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ===============================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500  ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy            =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.073 m. < smax  --->  O.K.
```

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-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
=========================================================================================


      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0060
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0048
           -. Rhomin < Rho < Rhomax  --->  O.K !

      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.030 m.
           -. Mn     = As*fy*(d-a/2)      =       74.75 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       67.27 kN-m.

      ( ). Check ratio of positive moment capacity.
           -. Rat_P  = Mu/phiMn =    0.939  <  1.000  --->  O.K.

 ===============================================================================
   [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
 ===============================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500  ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.030 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.304 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.300 m.
           -. s    =    0.220 m. < smax  --->  O.K.

      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0065
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0053
           -. Rhomin < Rho < Rhomax  --->  O.K !
```

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--------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                Gen 2022
======================================================================================


      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.033 m.
           -. Mn     = As*fy*(d-a/2)      =       81.86 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       73.67 kN-m.

      ( ). Check ratio of negative moment capacity.
           -. Rat_N  = Mu/phiMn =    0.928  <  1.000  --->  O.K.

 ================================================================================
    [[[*]]]   CALCULATE DATA OF SPECIAL PROVISIONS FOR SEISMIC DESIGN.
 ================================================================================

      ( ). Design parameters.
           -. fy  = 420000.00000 KPa.
           -. phi    = 1.0

      ( ). Calculate bending strength for design shear force(I, Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.I+ = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate bending strength for design shear force(J, Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.J- = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate bending strength for design shear force(I, Counter-Clockwise)
           -. Ast    =      0.0006 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0334 m.
           -. Mn.I- = Ast*fy*(d-a/2)  =       81.861 kN-m.

      ( ). Calculate bending strength for design shear force(J, Counter-Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.J+ = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate design shear force according to special provisions for seismic design.
           -. Alpha1  = 1.0000
           -. Span    =      2.5000 m.(Net Length)
           -. VzG     =      -4.442 kN.  (by Gravity-Direction Load).
```

```
-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
=========================================================================================

           -. Clockwise
              Ve11_CW = VzG + Alpha1*(Mn.I+ + Mn.J-)/Span =      55.357 kN.
              Ve12_CW = VzG - Alpha1*(Mn.I+ + Mn.J-)/Span =     -64.240 kN.
              Ve1_CW  = MAX[ |Ve11_CW|, |Ve12_CW| ] =      64.240 kN.
           -. Counter-Clockwise
              Ve11_CCW= VzG + Alpha1*(Mn.I- + Mn.J+)/Span =      58.202 kN.
              Ve12_CCW= VzG - Alpha1*(Mn.I- + Mn.J+)/Span =     -67.085 kN.
              Ve1_CCW = MAX[ |Ve11_CCW|, |Ve12_CCW| ] =      67.085 kN.

           -. Ve1     = MAX[ |Ve1_CW|, |Ve1_CCW| ]  =      67.085 kN.
           -. VzOrg   =     -57.180 kN.  (by Analysis).
           -. Ve2     =      57.180 kN.  (by Applied Alpha2).
           -.   Vu    = MAX[ |VzOrg|, MIN(|Ve2|,Ve1) ]  =      57.180 kN.

 ===============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY.
 ===============================================================================

      ( ). Compute shear strength of concrete.
           -. Vu     =       57.18 kN.
           -. Vc     = 0.17*SQRT(fc)*bw*d =       97.15 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc             =       72.86 kN.
           -. phiVc/2 < Vu < phiVc  --->  Minimum shear reinforcement is required.

      ( ). Compute required shear reinforcement. ( Av1 =  0.00007 m^2. )
           -. Avmin1 = 0.35*bw/fys           =2.500e-04 m^2/m.
           -. Avmin2 = 0.062*SQRT(fc)*bw/fys =2.343e-04 m^2/m.
           -. Av     = MAX[ Avmin1, Avmin2 ] =2.500e-04 m^2/m.
           -. N_leg  =  2
           -. Calculate spacing s1 = N_leg*Av1 / Av         =    0.568 m.
           -. Applied spacing s    = MIN[ s1, d/2, 600 mm ] =    0.180 m.
```

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-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
=========================================================================================

      *.midas Gen - RC-BEAM Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = BEAM,   MEMB =    21

      *.DESCRIPTION OF BEAM DATA (iSEC =     2) : V30*40
        Section Type : Rectangle (RECT)
        Beam Length (Span)            =         2.950 m.
        Section Depth (Hc)            =         0.400 m.
        Section Width (Bc)            =         0.300 m.
        Concrete Strength (fc)        =     28000.000 KPa.
        Modulus of Elasticity (Ec)    =  24870062.324 KPa.
        Main Rebar Strength (fy)      =    420000.000 KPa.
        Stirrups Strength (fys)       =    420000.000 KPa.
        Modulus of Elasticity (Es)    = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

      *.FORCES AND MOMENTS AT CHECK POINT <I> :
        Positive Bending Moment   P-Mu =       66.24 kN-m.,  LCB =  28
        Negative Bending Moment   N-Mu =       68.32 kN-m.,  LCB =  22
        Shear Force                Vu  =       57.07 kN.  ,  LCB =  22

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------
           Location    i     di( m.)       Rebar    Asi( m^2.)
        ---------------------------------------------------------
           Top         1      0.040         2-#6      0.00057
           Bottom      2      0.360         4-#4      0.00052
        ---------------------------------------------------------
           Stirrups : #3

 ===============================================================================
    [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ===============================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500  ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.073 m. < smax  --->  O.K.
```

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-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                    Gen 2022
=========================================================================================


      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0063
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0048
           -. Rhomin < Rho < Rhomax  --->  O.K !

      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.030 m.
           -. Mn     = As*fy*(d-a/2)      =       74.75 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       67.27 kN-m.

      ( ). Check ratio of positive moment capacity.
           -. Rat_P  = Mu/phiMn =    0.985  <  1.000  --->  O.K.

 ===================================================================================
    [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
 ===================================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500  ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.030 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.304 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.300 m.
           -. s    =    0.220 m. < smax  --->  O.K.

      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0065
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0053
           -. Rhomin < Rho < Rhomax  --->  O.K !
```

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-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                   Gen 2022
=========================================================================================


      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.033 m.
           -. Mn     = As*fy*(d-a/2)      =       81.86 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       73.67 kN-m.

      ( ). Check ratio of negative moment capacity.
           -. Rat_N  = Mu/phiMn =    0.927  <  1.000  --->  O.K.

 ===============================================================================
   [[[*]]]   CALCULATE DATA OF SPECIAL PROVISIONS FOR SEISMIC DESIGN.
 ===============================================================================

      ( ). Design parameters.
           -. fy  = 420000.00000 KPa.
           -. phi    = 1.0

      ( ). Calculate bending strength for design shear force(I, Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.I+ = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate bending strength for design shear force(J, Clockwise)
           -. Ast    =      0.0006 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0334 m.
           -. Mn.J- = Ast*fy*(d-a/2)  =       81.861 kN-m.

      ( ). Calculate bending strength for design shear force(I, Counter-Clockwise)
           -. Ast    =      0.0006 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0334 m.
           -. Mn.I- = Ast*fy*(d-a/2)  =       81.861 kN-m.

      ( ). Calculate bending strength for design shear force(J, Counter-Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.J+ = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate design shear force according to special provisions for seismic design.
           -. Alpha1  = 1.0000
           -. Span    =      2.5000 m.(Net Length)
           -. VzG     =      -3.906 kN.  (by Gravity-Direction Load).
```

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--------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
============================================================================================

          -. Clockwise
             Ve11_CW = VzG + Alpha1*(Mn.I+ + Mn.J-)/Span =      58.738 kN.
             Ve12_CW = VzG - Alpha1*(Mn.I+ + Mn.J-)/Span =     -66.549 kN.
             Ve1_CW  = MAX[ |Ve11_CW|, |Ve12_CW| ] =      66.549 kN.
          -. Counter-Clockwise
             Ve11_CCW= VzG + Alpha1*(Mn.I- + Mn.J+)/Span =      58.738 kN.
             Ve12_CCW= VzG - Alpha1*(Mn.I- + Mn.J+)/Span =     -66.549 kN.
             Ve1_CCW = MAX[ |Ve11_CCW|, |Ve12_CCW| ] =      66.549 kN.

          -. Ve1     = MAX[ |Ve1_CW|, |Ve1_CCW| ]  =      66.549 kN.
          -. VzOrg   =     -57.072 kN.  (by Analysis).
          -. Ve2     =      57.072 kN.  (by Applied Alpha2).
          -.   Vu    = MAX[ |VzOrg|, MIN(|Ve2|,Ve1) ]  =      57.072 kN.

 ===============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY.
 ===============================================================================

      ( ). Compute shear strength of concrete.
          -. Vu     =       57.07 kN.
          -. Vc     = 0.17*SQRT(fc)*bw*d =       97.15 kN.
          -. phi    = 0.75
          -. phiVc  = phi*Vc             =       72.86 kN.
          -. phiVc/2 < Vu < phiVc  --->  Minimum shear reinforcement is required.

      ( ). Compute required shear reinforcement. ( Av1 =  0.00007 m^2. )
          -. Avmin1 = 0.35*bw/fys           =2.500e-04 m^2/m.
          -. Avmin2 = 0.062*SQRT(fc)*bw/fys =2.343e-04 m^2/m.
          -. Av     = MAX[ Avmin1, Avmin2 ] =2.500e-04 m^2/m.
          -. N_leg  =  2
          -. Calculate spacing s1 = N_leg*Av1 / Av         =    0.568 m.
          -. Applied spacing s    = MIN[ s1, d/2, 600 mm ] =    0.180 m.
```

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-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
=========================================================================================

      *.midas Gen - RC-BEAM Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = BEAM,   MEMB =    22

      *.DESCRIPTION OF BEAM DATA (iSEC =     2) : V30*40
        Section Type : Rectangle (RECT)
        Beam Length (Span)            =         2.950 m.
        Section Depth (Hc)            =         0.400 m.
        Section Width (Bc)            =         0.300 m.
        Concrete Strength (fc)        =     28000.000 KPa.
        Modulus of Elasticity (Ec)    =  24870062.324 KPa.
        Main Rebar Strength (fy)      =    420000.000 KPa.
        Stirrups Strength (fys)       =    420000.000 KPa.
        Modulus of Elasticity (Es)    = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

      *.FORCES AND MOMENTS AT CHECK POINT <I> :
        Positive Bending Moment   P-Mu =       66.25 kN-m.,  LCB =  28
        Negative Bending Moment   N-Mu =       68.32 kN-m.,  LCB =  22
        Shear Force                Vu  =       57.07 kN.  ,  LCB =  22

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------
           Location    i     di( m.)       Rebar    Asi( m^2.)
        ---------------------------------------------------------
           Top         1      0.040         2-#6      0.00057
           Bottom      2      0.360         4-#4      0.00052
        ---------------------------------------------------------
           Stirrups : #3

 ===============================================================================
    [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ===============================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.073 m. < smax  --->  O.K.
```

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----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
========================================================================================


      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0063
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0048
           -. Rhomin < Rho < Rhomax  --->  O.K !

      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.030 m.
           -. Mn     = As*fy*(d-a/2)      =       74.75 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       67.27 kN-m.

      ( ). Check ratio of positive moment capacity.
           -. Rat_P  = Mu/phiMn =    0.985  <  1.000  --->  O.K.

 ===============================================================================
    [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
 ===============================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy              =2.800e+05 KPa.
           -. cc   =    0.030 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.304 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.300 m.
           -. s    =    0.220 m. < smax  --->  O.K.

      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0065
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0053
           -. Rhomin < Rho < Rhomax  --->  O.K !
```

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 midas Gen - RC-Beam Design     [ NSR-10 ]                                        Gen 2022
===========================================================================================


      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.033 m.
           -. Mn     = As*fy*(d-a/2)      =       81.86 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       73.67 kN-m.

      ( ). Check ratio of negative moment capacity.
           -. Rat_N  = Mu/phiMn =    0.927  <  1.000  --->  O.K.

 ================================================================================
    [[[*]]]   CALCULATE DATA OF SPECIAL PROVISIONS FOR SEISMIC DESIGN.
 ================================================================================

      ( ). Design parameters.
           -. fy  = 420000.00000 KPa.
           -. phi    = 1.0

      ( ). Calculate bending strength for design shear force(I, Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.I+ = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate bending strength for design shear force(J, Clockwise)
           -. Ast    =      0.0006 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0334 m.
           -. Mn.J- = Ast*fy*(d-a/2)  =       81.861 kN-m.

      ( ). Calculate bending strength for design shear force(I, Counter-Clockwise)
           -. Ast    =      0.0006 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0334 m.
           -. Mn.I- = Ast*fy*(d-a/2)  =       81.861 kN-m.

      ( ). Calculate bending strength for design shear force(J, Counter-Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.J+ = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate design shear force according to special provisions for seismic design.
           -. Alpha1  = 1.0000
           -. Span    =      2.5000 m.(Net Length)
           -. VzG     =      -3.900 kN.  (by Gravity-Direction Load).
```

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 midas Gen - RC-Beam Design     [ NSR-10 ]                                 Gen 2022
===========================================================================================

           -. Clockwise
              Ve11_CW = VzG + Alpha1*(Mn.I+ + Mn.J-)/Span =      58.743 kN.
              Ve12_CW = VzG - Alpha1*(Mn.I+ + Mn.J-)/Span =     -66.544 kN.
              Ve1_CW  = MAX[ |Ve11_CW|, |Ve12_CW| ] =      66.544 kN.
           -. Counter-Clockwise
              Ve11_CCW= VzG + Alpha1*(Mn.I- + Mn.J+)/Span =      58.743 kN.
              Ve12_CCW= VzG - Alpha1*(Mn.I- + Mn.J+)/Span =     -66.544 kN.
              Ve1_CCW = MAX[ |Ve11_CCW|, |Ve12_CCW| ] =      66.544 kN.

           -. Ve1     = MAX[ |Ve1_CW|, |Ve1_CCW| ]  =      66.544 kN.
           -. VzOrg   =     -57.072 kN.  (by Analysis).
           -. Ve2     =      57.072 kN.  (by Applied Alpha2).
           -.   Vu    = MAX[ |VzOrg|, MIN(|Ve2|,Ve1) ]  =      57.072 kN.

 ================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY.
 ================================================================================

      ( ). Compute shear strength of concrete.
           -. Vu     =       57.07 kN.
           -. Vc     = 0.17*SQRT(fc)*bw*d =       97.15 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc             =       72.86 kN.
           -. phiVc/2 < Vu < phiVc  --->  Minimum shear reinforcement is required.

      ( ). Compute required shear reinforcement. ( Av1 =  0.00007 m^2. )
           -. Avmin1 = 0.35*bw/fys           =2.500e-04 m^2/m.
           -. Avmin2 = 0.062*SQRT(fc)*bw/fys =2.343e-04 m^2/m.
           -. Av     = MAX[ Avmin1, Avmin2 ] =2.500e-04 m^2/m.
           -. N_leg  =  2
           -. Calculate spacing s1 = N_leg*Av1 / Av         =    0.568 m.
           -. Applied spacing s    = MIN[ s1, d/2, 600 mm ] =    0.180 m.
```

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-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
=========================================================================================

      *.midas Gen - RC-BEAM Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = BEAM,   MEMB =    23

      *.DESCRIPTION OF BEAM DATA (iSEC =     2) : V30*40
        Section Type : Rectangle (RECT)
        Beam Length (Span)            =         2.950 m.
        Section Depth (Hc)            =         0.400 m.
        Section Width (Bc)            =         0.300 m.
        Concrete Strength (fc)        =     28000.000 KPa.
        Modulus of Elasticity (Ec)    =  24870062.324 KPa.
        Main Rebar Strength (fy)      =    420000.000 KPa.
        Stirrups Strength (fys)       =    420000.000 KPa.
        Modulus of Elasticity (Es)    = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

      *.FORCES AND MOMENTS AT CHECK POINT <I> :
        Positive Bending Moment   P-Mu =       66.30 kN-m.,  LCB =  28
        Negative Bending Moment   N-Mu =       68.48 kN-m.,  LCB =  22
        Shear Force                Vu  =       57.20 kN.  ,  LCB =  22

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------
           Location    i     di( m.)       Rebar    Asi( m^2.)
        ---------------------------------------------------------
           Top         1      0.040         2-#6      0.00057
           Bottom      2      0.360         4-#4      0.00052
        ---------------------------------------------------------
           Stirrups : #3

 ===============================================================================
    [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ===============================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.073 m. < smax  --->  O.K.
```

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-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
=========================================================================================


      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0063
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0048
           -. Rhomin < Rho < Rhomax  --->  O.K !

      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.030 m.
           -. Mn     = As*fy*(d-a/2)      =       74.75 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       67.27 kN-m.

      ( ). Check ratio of positive moment capacity.
           -. Rat_P  = Mu/phiMn =    0.986  <  1.000  --->  O.K.

 ===================================================================================
    [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
 ===================================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500  ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.030 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.304 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.300 m.
           -. s    =    0.220 m. < smax  --->  O.K.

      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0065
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0053
           -. Rhomin < Rho < Rhomax  --->  O.K !
```

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----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                     Gen 2022
========================================================================================


      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.033 m.
           -. Mn     = As*fy*(d-a/2)      =       81.86 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       73.67 kN-m.

      ( ). Check ratio of negative moment capacity.
           -. Rat_N  = Mu/phiMn =    0.930  <  1.000  --->  O.K.

 ===============================================================================
    [[[*]]]   CALCULATE DATA OF SPECIAL PROVISIONS FOR SEISMIC DESIGN.
 ===============================================================================

      ( ). Design parameters.
           -. fy  = 420000.00000 KPa.
           -. phi    = 1.0

      ( ). Calculate bending strength for design shear force(I, Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.I+ = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate bending strength for design shear force(J, Clockwise)
           -. Ast    =      0.0006 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0334 m.
           -. Mn.J- = Ast*fy*(d-a/2)  =       81.861 kN-m.

      ( ). Calculate bending strength for design shear force(I, Counter-Clockwise)
           -. Ast    =      0.0006 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0334 m.
           -. Mn.I- = Ast*fy*(d-a/2)  =       81.861 kN-m.

      ( ). Calculate bending strength for design shear force(J, Counter-Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.J+ = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate design shear force according to special provisions for seismic design.
           -. Alpha1  = 1.0000
           -. Span    =      2.5000 m.(Net Length)
           -. VzG     =      -3.931 kN.  (by Gravity-Direction Load).
```

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------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
==========================================================================================

           -. Clockwise
              Ve11_CW = VzG + Alpha1*(Mn.I+ + Mn.J-)/Span =      58.712 kN.
              Ve12_CW = VzG - Alpha1*(Mn.I+ + Mn.J-)/Span =     -66.574 kN.
              Ve1_CW  = MAX[ |Ve11_CW|, |Ve12_CW| ] =      66.574 kN.
           -. Counter-Clockwise
              Ve11_CCW= VzG + Alpha1*(Mn.I- + Mn.J+)/Span =      58.712 kN.
              Ve12_CCW= VzG - Alpha1*(Mn.I- + Mn.J+)/Span =     -66.574 kN.
              Ve1_CCW = MAX[ |Ve11_CCW|, |Ve12_CCW| ] =      66.574 kN.

           -. Ve1     = MAX[ |Ve1_CW|, |Ve1_CCW| ]  =      66.574 kN.
           -. VzOrg   =     -57.198 kN.  (by Analysis).
           -. Ve2     =      57.198 kN.  (by Applied Alpha2).
           -.   Vu    = MAX[ |VzOrg|, MIN(|Ve2|,Ve1) ]  =      57.198 kN.

 ===============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY.
 ===============================================================================

      ( ). Compute shear strength of concrete.
           -. Vu     =       57.20 kN.
           -. Vc     = 0.17*SQRT(fc)*bw*d =       97.15 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc             =       72.86 kN.
           -. phiVc/2 < Vu < phiVc  --->  Minimum shear reinforcement is required.

      ( ). Compute required shear reinforcement. ( Av1 =  0.00007 m^2. )
           -. Avmin1 = 0.35*bw/fys           =2.500e-04 m^2/m.
           -. Avmin2 = 0.062*SQRT(fc)*bw/fys =2.343e-04 m^2/m.
           -. Av     = MAX[ Avmin1, Avmin2 ] =2.500e-04 m^2/m.
           -. N_leg  =  2
           -. Calculate spacing s1 = N_leg*Av1 / Av         =    0.568 m.
           -. Applied spacing s    = MIN[ s1, d/2, 600 mm ] =    0.180 m.
```

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---------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                 Gen 2022
=======================================================================================

      *.midas Gen - RC-BEAM Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = BEAM,   MEMB =    24

      *.DESCRIPTION OF BEAM DATA (iSEC =     2) : V30*40
        Section Type : Rectangle (RECT)
        Beam Length (Span)            =         2.950 m.
        Section Depth (Hc)            =         0.400 m.
        Section Width (Bc)            =         0.300 m.
        Concrete Strength (fc)        =     28000.000 KPa.
        Modulus of Elasticity (Ec)    =  24870062.324 KPa.
        Main Rebar Strength (fy)      =    420000.000 KPa.
        Stirrups Strength (fys)       =    420000.000 KPa.
        Modulus of Elasticity (Es)    = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

      *.FORCES AND MOMENTS AT CHECK POINT <I> :
        Positive Bending Moment   P-Mu =       66.30 kN-m.,  LCB =  28
        Negative Bending Moment   N-Mu =       68.48 kN-m.,  LCB =  22
        Shear Force                Vu  =       57.19 kN.  ,  LCB =  22

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------
           Location    i     di( m.)       Rebar    Asi( m^2.)
        ---------------------------------------------------------
           Top         1      0.040         2-#6      0.00057
           Bottom      2      0.360         4-#4      0.00052
        ---------------------------------------------------------
           Stirrups : #3

 ================================================================================
    [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ================================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.073 m. < smax  --->  O.K.
```

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-------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
===========================================================================================


      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0063
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0048
           -. Rhomin < Rho < Rhomax  --->  O.K !

      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.030 m.
           -. Mn     = As*fy*(d-a/2)      =       74.75 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       67.27 kN-m.

      ( ). Check ratio of positive moment capacity.
           -. Rat_P  = Mu/phiMn =    0.986  <  1.000  --->  O.K.

 ===============================================================================
    [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
 ===============================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500  ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy              =2.800e+05 KPa.
           -. cc   =    0.030 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.304 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.300 m.
           -. s    =    0.220 m. < smax  --->  O.K.

      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0065
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0053
           -. Rhomin < Rho < Rhomax  --->  O.K !
```

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-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
=========================================================================================


      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.033 m.
           -. Mn     = As*fy*(d-a/2)      =       81.86 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       73.67 kN-m.

      ( ). Check ratio of negative moment capacity.
           -. Rat_N  = Mu/phiMn =    0.929  <  1.000  --->  O.K.

 ===============================================================================
    [[[*]]]   CALCULATE DATA OF SPECIAL PROVISIONS FOR SEISMIC DESIGN.
 ===============================================================================

      ( ). Design parameters.
           -. fy  = 420000.00000 KPa.
           -. phi    = 1.0

      ( ). Calculate bending strength for design shear force(I, Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.I+ = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate bending strength for design shear force(J, Clockwise)
           -. Ast    =      0.0006 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0334 m.
           -. Mn.J- = Ast*fy*(d-a/2)  =       81.861 kN-m.

      ( ). Calculate bending strength for design shear force(I, Counter-Clockwise)
           -. Ast    =      0.0006 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0334 m.
           -. Mn.I- = Ast*fy*(d-a/2)  =       81.861 kN-m.

      ( ). Calculate bending strength for design shear force(J, Counter-Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.J+ = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate design shear force according to special provisions for seismic design.
           -. Alpha1  = 1.0000
           -. Span    =      2.5000 m.(Net Length)
           -. VzG     =      -3.928 kN.  (by Gravity-Direction Load).
```

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-------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                   Gen 2022
===========================================================================================

          -. Clockwise
             Ve11_CW = VzG + Alpha1*(Mn.I+ + Mn.J-)/Span =      58.715 kN.
             Ve12_CW = VzG - Alpha1*(Mn.I+ + Mn.J-)/Span =     -66.572 kN.
             Ve1_CW  = MAX[ |Ve11_CW|, |Ve12_CW| ] =      66.572 kN.
          -. Counter-Clockwise
             Ve11_CCW= VzG + Alpha1*(Mn.I- + Mn.J+)/Span =      58.715 kN.
             Ve12_CCW= VzG - Alpha1*(Mn.I- + Mn.J+)/Span =     -66.572 kN.
             Ve1_CCW = MAX[ |Ve11_CCW|, |Ve12_CCW| ] =      66.572 kN.

          -. Ve1     = MAX[ |Ve1_CW|, |Ve1_CCW| ]  =      66.572 kN.
          -. VzOrg   =     -57.193 kN.  (by Analysis).
          -. Ve2     =      57.193 kN.  (by Applied Alpha2).
          -.   Vu    = MAX[ |VzOrg|, MIN(|Ve2|,Ve1) ]  =      57.193 kN.

 ===============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY.
 ===============================================================================

      ( ). Compute shear strength of concrete.
          -. Vu     =       57.19 kN.
          -. Vc     = 0.17*SQRT(fc)*bw*d =       97.15 kN.
          -. phi    = 0.75
          -. phiVc  = phi*Vc             =       72.86 kN.
          -. phiVc/2 < Vu < phiVc  --->  Minimum shear reinforcement is required.

      ( ). Compute required shear reinforcement. ( Av1 =  0.00007 m^2. )
          -. Avmin1 = 0.35*bw/fys           =2.500e-04 m^2/m.
          -. Avmin2 = 0.062*SQRT(fc)*bw/fys =2.343e-04 m^2/m.
          -. Av     = MAX[ Avmin1, Avmin2 ] =2.500e-04 m^2/m.
          -. N_leg  =  2
          -. Calculate spacing s1 = N_leg*Av1 / Av         =    0.568 m.
          -. Applied spacing s    = MIN[ s1, d/2, 600 mm ] =    0.180 m.
```

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-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
=========================================================================================

      *.midas Gen - RC-BEAM Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = BEAM,   MEMB = 14311

      *.DESCRIPTION OF BEAM DATA (iSEC =     2) : V30*40
        Section Type : Rectangle (RECT)
        Beam Length (Span)          =        2.950 m.
        Section Depth (Hc)          =        0.400 m.
        Section Width (Bc)          =        0.300 m.
        Concrete Strength (fc)      =    28000.000 KPa.
        Modulus of Elasticity (Ec)  =  24870062.324 KPa.
        Main Rebar Strength (fy)    =   420000.000 KPa.
        Stirrups Strength (fys)     =   420000.000 KPa.
        Modulus of Elasticity (Es)  = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

      *.FORCES AND MOMENTS AT CHECK POINT <I> :
        Positive Bending Moment   P-Mu =       64.33 kN-m.,  LCB =  28
        Negative Bending Moment   N-Mu =       67.42 kN-m.,  LCB =  22
        Shear Force                Vu  =       57.65 kN.  ,  LCB =  22

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------
           Location    i     di( m.)       Rebar    Asi( m^2.)
        ---------------------------------------------------------
           Top         1      0.040         2-#6      0.00057
           Bottom      2      0.360         4-#4      0.00052
        ---------------------------------------------------------
           Stirrups : #3

 ===============================================================================
    [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ===============================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.073 m. < smax  --->  O.K.
```

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-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                 Gen 2022
=========================================================================================


      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0061
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0048
           -. Rhomin < Rho < Rhomax  --->  O.K !

      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.030 m.
           -. Mn     = As*fy*(d-a/2)      =       74.75 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       67.27 kN-m.

      ( ). Check ratio of positive moment capacity.
           -. Rat_P  = Mu/phiMn =    0.956  <  1.000  --->  O.K.

 ===================================================================================
    [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
 ===================================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500  ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy              =2.800e+05 KPa.
           -. cc   =    0.030 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.304 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.300 m.
           -. s    =    0.220 m. < smax  --->  O.K.

      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0064
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0053
           -. Rhomin < Rho < Rhomax  --->  O.K !
```

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--------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                 Gen 2022
============================================================================================


      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.033 m.
           -. Mn     = As*fy*(d-a/2)      =       81.86 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       73.67 kN-m.

      ( ). Check ratio of negative moment capacity.
           -. Rat_N  = Mu/phiMn =    0.915  <  1.000  --->  O.K.

 ================================================================================
    [[[*]]]   CALCULATE DATA OF SPECIAL PROVISIONS FOR SEISMIC DESIGN.
 ================================================================================

      ( ). Design parameters.
           -. fy  = 420000.00000 KPa.
           -. phi    = 1.0

      ( ). Calculate bending strength for design shear force(I, Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.I+ = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate bending strength for design shear force(J, Clockwise)
           -. Ast    =      0.0006 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0334 m.
           -. Mn.J- = Ast*fy*(d-a/2)  =       81.861 kN-m.

      ( ). Calculate bending strength for design shear force(I, Counter-Clockwise)
           -. Ast    =      0.0006 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0334 m.
           -. Mn.I- = Ast*fy*(d-a/2)  =       81.861 kN-m.

      ( ). Calculate bending strength for design shear force(J, Counter-Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.J+ = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate design shear force according to special provisions for seismic design.
           -. Alpha1  = 1.0000
           -. Span    =      2.5000 m.(Net Length)
           -. VzG     =      -4.654 kN.  (by Gravity-Direction Load).
```

```
-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                 Gen 2022
=========================================================================================

          -. Clockwise
             Ve11_CW = VzG + Alpha1*(Mn.I+ + Mn.J-)/Span =      57.989 kN.
             Ve12_CW = VzG - Alpha1*(Mn.I+ + Mn.J-)/Span =     -67.297 kN.
             Ve1_CW  = MAX[ |Ve11_CW|, |Ve12_CW| ] =      67.297 kN.
          -. Counter-Clockwise
             Ve11_CCW= VzG + Alpha1*(Mn.I- + Mn.J+)/Span =      57.989 kN.
             Ve12_CCW= VzG - Alpha1*(Mn.I- + Mn.J+)/Span =     -67.297 kN.
             Ve1_CCW = MAX[ |Ve11_CCW|, |Ve12_CCW| ] =      67.297 kN.

          -. Ve1     = MAX[ |Ve1_CW|, |Ve1_CCW| ]  =      67.297 kN.
          -. VzOrg   =     -57.649 kN.  (by Analysis).
          -. Ve2     =      57.649 kN.  (by Applied Alpha2).
          -.   Vu    = MAX[ |VzOrg|, MIN(|Ve2|,Ve1) ]  =      57.649 kN.

 ===============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY.
 ===============================================================================

      ( ). Compute shear strength of concrete.
          -. Vu     =       57.65 kN.
          -. Vc     = 0.17*SQRT(fc)*bw*d =       97.15 kN.
          -. phi    = 0.75
          -. phiVc  = phi*Vc             =       72.86 kN.
          -. phiVc/2 < Vu < phiVc  --->  Minimum shear reinforcement is required.

      ( ). Compute required shear reinforcement. ( Av1 =  0.00007 m^2. )
          -. Avmin1 = 0.35*bw/fys           =2.500e-04 m^2/m.
          -. Avmin2 = 0.062*SQRT(fc)*bw/fys =2.343e-04 m^2/m.
          -. Av     = MAX[ Avmin1, Avmin2 ] =2.500e-04 m^2/m.
          -. N_leg  =  2
          -. Calculate spacing s1 = N_leg*Av1 / Av         =    0.568 m.
          -. Applied spacing s    = MIN[ s1, d/2, 600 mm ] =    0.180 m.
```

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------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
==========================================================================================

      *.midas Gen - RC-BEAM Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = BEAM,   MEMB = 14313

      *.DESCRIPTION OF BEAM DATA (iSEC =     2) : V30*40
        Section Type : Rectangle (RECT)
        Beam Length (Span)            =         2.950 m.
        Section Depth (Hc)            =         0.400 m.
        Section Width (Bc)            =         0.300 m.
        Concrete Strength (fc)        =     28000.000 KPa.
        Modulus of Elasticity (Ec)    =  24870062.324 KPa.
        Main Rebar Strength (fy)      =    420000.000 KPa.
        Stirrups Strength (fys)       =    420000.000 KPa.
        Modulus of Elasticity (Es)    = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

      *.FORCES AND MOMENTS AT CHECK POINT <I> :
        Positive Bending Moment   P-Mu =       64.30 kN-m.,  LCB =  25
        Negative Bending Moment   N-Mu =       65.35 kN-m.,  LCB =  19
        Shear Force                Vu  =       55.48 kN.  ,  LCB =  19

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------
           Location    i     di( m.)       Rebar    Asi( m^2.)
        ---------------------------------------------------------
           Top         1      0.040         4-#4      0.00052
           Bottom      2      0.360         4-#4      0.00052
        ---------------------------------------------------------
           Stirrups : #3

 ================================================================================
    [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ================================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500  ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.073 m. < smax  --->  O.K.
```

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------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
==========================================================================================


      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0061
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0048
           -. Rhomin < Rho < Rhomax  --->  O.K !

      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.030 m.
           -. Mn     = As*fy*(d-a/2)      =       74.75 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       67.27 kN-m.

      ( ). Check ratio of positive moment capacity.
           -. Rat_P  = Mu/phiMn =    0.956  <  1.000  --->  O.K.

 ===================================================================================
    [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
 ===================================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500  ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.073 m. < smax  --->  O.K.

      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0062
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0048
           -. Rhomin < Rho < Rhomax  --->  O.K !
```

```
--------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                Gen 2022
======================================================================================


      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.030 m.
           -. Mn     = As*fy*(d-a/2)      =       74.75 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       67.27 kN-m.

      ( ). Check ratio of negative moment capacity.
           -. Rat_N  = Mu/phiMn =    0.971  <  1.000  --->  O.K.

 ============================================================================
    [[[*]]]   CALCULATE DATA OF SPECIAL PROVISIONS FOR SEISMIC DESIGN.
 ============================================================================

      ( ). Design parameters.
           -. fy  = 420000.00000 KPa.
           -. phi    = 1.0

      ( ). Calculate bending strength for design shear force(I, Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.I+ = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate bending strength for design shear force(J, Clockwise)
           -. Ast    =      0.0006 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0334 m.
           -. Mn.J- = Ast*fy*(d-a/2)  =       81.861 kN-m.

      ( ). Calculate bending strength for design shear force(I, Counter-Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.I- = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate bending strength for design shear force(J, Counter-Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.J+ = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate design shear force according to special provisions for seismic design.
           -. Alpha1  = 1.0000
           -. Span    =      2.5000 m.(Net Length)
           -. VzG     =      -4.141 kN.  (by Gravity-Direction Load).
```

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----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
========================================================================================

           -. Clockwise
              Ve11_CW = VzG + Alpha1*(Mn.I+ + Mn.J-)/Span =      58.503 kN.
              Ve12_CW = VzG - Alpha1*(Mn.I+ + Mn.J-)/Span =     -66.784 kN.
              Ve1_CW  = MAX[ |Ve11_CW|, |Ve12_CW| ] =      66.784 kN.
           -. Counter-Clockwise
              Ve11_CCW= VzG + Alpha1*(Mn.I- + Mn.J+)/Span =      55.658 kN.
              Ve12_CCW= VzG - Alpha1*(Mn.I- + Mn.J+)/Span =     -63.939 kN.
              Ve1_CCW = MAX[ |Ve11_CCW|, |Ve12_CCW| ] =      63.939 kN.

           -. Ve1     = MAX[ |Ve1_CW|, |Ve1_CCW| ]  =      66.784 kN.
           -. VzOrg   =     -55.482 kN.  (by Analysis).
           -. Ve2     =      55.482 kN.  (by Applied Alpha2).
           -.   Vu    = MAX[ |VzOrg|, MIN(|Ve2|,Ve1) ]  =      55.482 kN.

 ===============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY.
 ===============================================================================

      ( ). Compute shear strength of concrete.
           -. Vu     =       55.48 kN.
           -. Vc     = 0.17*SQRT(fc)*bw*d =       97.15 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc             =       72.86 kN.
           -. phiVc/2 < Vu < phiVc  --->  Minimum shear reinforcement is required.

      ( ). Compute required shear reinforcement. ( Av1 =  0.00007 m^2. )
           -. Avmin1 = 0.35*bw/fys           =2.500e-04 m^2/m.
           -. Avmin2 = 0.062*SQRT(fc)*bw/fys =2.343e-04 m^2/m.
           -. Av     = MAX[ Avmin1, Avmin2 ] =2.500e-04 m^2/m.
           -. N_leg  =  2
           -. Calculate spacing s1 = N_leg*Av1 / Av         =    0.568 m.
           -. Applied spacing s    = MIN[ s1, d/2, 600 mm ] =    0.180 m.
```

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-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
=========================================================================================

      *.midas Gen - RC-BEAM Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = BEAM,   MEMB = 14315

      *.DESCRIPTION OF BEAM DATA (iSEC =     3) : V40*40
        Section Type : Rectangle (RECT)
        Beam Length (Span)              =         2.950 m.
        Section Depth (Hc)              =         0.400 m.
        Section Width (Bc)              =         0.400 m.
        Concrete Strength (fc)          =     28000.000 KPa.
        Modulus of Elasticity (Ec)      =  24870062.324 KPa.
        Main Rebar Strength (fy)        =    420000.000 KPa.
        Stirrups Strength (fys)         =    420000.000 KPa.
        Modulus of Elasticity (Es)      = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

      *.FORCES AND MOMENTS AT CHECK POINT <I> :
        Positive Bending Moment   P-Mu =        2.58 kN-m.,  LCB =  12
        Negative Bending Moment   N-Mu =       13.19 kN-m.,  LCB =  19
        Shear Force                Vu  =       72.14 kN.  ,  LCB =  19

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------
           Location    i     di( m.)       Rebar    Asi( m^2.)
        ---------------------------------------------------------
           Top         1      0.040         3-#4      0.00039
           Bottom      2      0.360         3-#4      0.00039
        ---------------------------------------------------------
           Stirrups : #3

 ===============================================================================
    [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ===============================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.160 m. < smax  --->  O.K.
```

```
-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
=========================================================================================


      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0002
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0002
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0027
           -. Rhomin < Rho < Rhomax  --->  O.K !

      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.017 m.
           -. Mn     = As*fy*(d-a/2)      =       57.14 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       51.43 kN-m.

      ( ). Check ratio of positive moment capacity.
           -. Rat_P  = Mu/phiMn =    0.050  <  1.000  --->  O.K.

 ==================================================================================
    [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
 ==================================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500  ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.160 m. < smax  --->  O.K.

      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0009
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0009
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0027
           -. Rhomin < Rho < Rhomax  --->  O.K !
```

```
-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
=========================================================================================


      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.017 m.
           -. Mn     = As*fy*(d-a/2)      =       57.14 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       51.43 kN-m.

      ( ). Check ratio of negative moment capacity.
           -. Rat_N  = Mu/phiMn =    0.257  <  1.000  --->  O.K.

 ===============================================================================
    [[[*]]]   CALCULATE DATA OF SPECIAL PROVISIONS FOR SEISMIC DESIGN.
 ===============================================================================

      ( ). Design parameters.
           -. fy  = 420000.00000 KPa.
           -. phi    = 1.0

      ( ). Calculate bending strength for design shear force(I, Clockwise)
           -. Ast    =      0.0004 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0171 m.
           -. Mn.I+ = Ast*fy*(d-a/2)  =       57.141 kN-m.

      ( ). Calculate bending strength for design shear force(J, Clockwise)
           -. Ast    =      0.0004 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0171 m.
           -. Mn.J- = Ast*fy*(d-a/2)  =       57.141 kN-m.

      ( ). Calculate bending strength for design shear force(I, Counter-Clockwise)
           -. Ast    =      0.0004 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0171 m.
           -. Mn.I- = Ast*fy*(d-a/2)  =       57.141 kN-m.

      ( ). Calculate bending strength for design shear force(J, Counter-Clockwise)
           -. Ast    =      0.0004 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0171 m.
           -. Mn.J+ = Ast*fy*(d-a/2)  =       57.141 kN-m.

      ( ). Calculate design shear force according to special provisions for seismic design.
           -. Alpha1  = 1.0000
           -. Span    =      2.9500 m.
           -. VzG     =     -33.165 kN.  (by Gravity-Direction Load).
```

```
-------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                 Gen 2022
===========================================================================================

          -. Clockwise
             Ve11_CW = VzG + Alpha1*(Mn.I+ + Mn.J-)/Span =       5.575 kN.
             Ve12_CW = VzG - Alpha1*(Mn.I+ + Mn.J-)/Span =     -71.904 kN.
             Ve1_CW  = MAX[ |Ve11_CW|, |Ve12_CW| ] =      71.904 kN.
          -. Counter-Clockwise
             Ve11_CCW= VzG + Alpha1*(Mn.I- + Mn.J+)/Span =       5.575 kN.
             Ve12_CCW= VzG - Alpha1*(Mn.I- + Mn.J+)/Span =     -71.904 kN.
             Ve1_CCW = MAX[ |Ve11_CCW|, |Ve12_CCW| ] =      71.904 kN.

          -. Ve1     = MAX[ |Ve1_CW|, |Ve1_CCW| ]  =      71.904 kN.
          -. VzOrg   =     -72.142 kN.  (by Analysis).
          -. Ve2     =      72.142 kN.  (by Applied Alpha2).
          -.   Vu    = MAX[ |VzOrg|, MIN(|Ve2|,Ve1) ]  =      72.142 kN.

 ===============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY.
 ===============================================================================

      ( ). Compute shear strength of concrete.
          -. Vu     =       72.14 kN.
          -. Vc     = 0.17*SQRT(fc)*bw*d =      129.54 kN.
          -. phi    = 0.75
          -. phiVc  = phi*Vc             =       97.15 kN.
          -. phiVc/2 < Vu < phiVc  --->  Minimum shear reinforcement is required.

      ( ). Compute required shear reinforcement. ( Av1 =  0.00007 m^2. )
          -. Avmin1 = 0.35*bw/fys           =3.333e-04 m^2/m.
          -. Avmin2 = 0.062*SQRT(fc)*bw/fys =3.125e-04 m^2/m.
          -. Av     = MAX[ Avmin1, Avmin2 ] =3.333e-04 m^2/m.
          -. N_leg  =  2
          -. Calculate spacing s1 = N_leg*Av1 / Av         =    0.426 m.
          -. Applied spacing s    = MIN[ s1, d/2, 600 mm ] =    0.180 m.
```

```
------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
==========================================================================================

      *.midas Gen - RC-BEAM Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = BEAM,   MEMB = 14317

      *.DESCRIPTION OF BEAM DATA (iSEC =     2) : V30*40
        Section Type : Rectangle (RECT)
        Beam Length (Span)          =        2.950 m.
        Section Depth (Hc)          =        0.400 m.
        Section Width (Bc)          =        0.300 m.
        Concrete Strength (fc)      =    28000.000 KPa.
        Modulus of Elasticity (Ec)  =  24870062.324 KPa.
        Main Rebar Strength (fy)    =   420000.000 KPa.
        Stirrups Strength (fys)     =   420000.000 KPa.
        Modulus of Elasticity (Es)  = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

      *.FORCES AND MOMENTS AT CHECK POINT <I> :
        Positive Bending Moment   P-Mu =       64.24 kN-m.,  LCB =  28
        Negative Bending Moment   N-Mu =       67.51 kN-m.,  LCB =  22
        Shear Force                Vu  =       57.70 kN.  ,  LCB =  22

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------
           Location    i     di( m.)       Rebar    Asi( m^2.)
        ---------------------------------------------------------
           Top         1      0.040         2-#6      0.00057
           Bottom      2      0.360         4-#4      0.00052
        ---------------------------------------------------------
           Stirrups : #3

 ==========================================================================
    [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ==========================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.073 m. < smax  --->  O.K.
```

```
------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                   Gen 2022
==========================================================================================


      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0061
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0048
           -. Rhomin < Rho < Rhomax  --->  O.K !

      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.030 m.
           -. Mn     = As*fy*(d-a/2)      =       74.75 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       67.27 kN-m.

      ( ). Check ratio of positive moment capacity.
           -. Rat_P  = Mu/phiMn =    0.955  <  1.000  --->  O.K.

 ===================================================================================
    [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
 ===================================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500  ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.030 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.304 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.300 m.
           -. s    =    0.220 m. < smax  --->  O.K.

      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0064
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0053
           -. Rhomin < Rho < Rhomax  --->  O.K !
```

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-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                 Gen 2022
=========================================================================================


      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.033 m.
           -. Mn     = As*fy*(d-a/2)      =       81.86 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       73.67 kN-m.

      ( ). Check ratio of negative moment capacity.
           -. Rat_N  = Mu/phiMn =    0.916  <  1.000  --->  O.K.

 ===============================================================================
   [[[*]]]   CALCULATE DATA OF SPECIAL PROVISIONS FOR SEISMIC DESIGN.
 ===============================================================================

      ( ). Design parameters.
           -. fy  = 420000.00000 KPa.
           -. phi    = 1.0

      ( ). Calculate bending strength for design shear force(I, Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.I+ = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate bending strength for design shear force(J, Clockwise)
           -. Ast    =      0.0006 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0334 m.
           -. Mn.J- = Ast*fy*(d-a/2)  =       81.861 kN-m.

      ( ). Calculate bending strength for design shear force(I, Counter-Clockwise)
           -. Ast    =      0.0006 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0334 m.
           -. Mn.I- = Ast*fy*(d-a/2)  =       81.861 kN-m.

      ( ). Calculate bending strength for design shear force(J, Counter-Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.J+ = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate design shear force according to special provisions for seismic design.
           -. Alpha1  = 1.0000
           -. Span    =      2.5000 m.(Net Length)
           -. VzG     =      -4.695 kN.  (by Gravity-Direction Load).
```

```
---------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                Gen 2022
=======================================================================================

          -. Clockwise
             Ve11_CW = VzG + Alpha1*(Mn.I+ + Mn.J-)/Span =      57.948 kN.
             Ve12_CW = VzG - Alpha1*(Mn.I+ + Mn.J-)/Span =     -67.339 kN.
             Ve1_CW  = MAX[ |Ve11_CW|, |Ve12_CW| ] =      67.339 kN.
          -. Counter-Clockwise
             Ve11_CCW= VzG + Alpha1*(Mn.I- + Mn.J+)/Span =      57.948 kN.
             Ve12_CCW= VzG - Alpha1*(Mn.I- + Mn.J+)/Span =     -67.339 kN.
             Ve1_CCW = MAX[ |Ve11_CCW|, |Ve12_CCW| ] =      67.339 kN.

          -. Ve1     = MAX[ |Ve1_CW|, |Ve1_CCW| ]  =      67.339 kN.
          -. VzOrg   =     -57.703 kN.  (by Analysis).
          -. Ve2     =      57.703 kN.  (by Applied Alpha2).
          -.   Vu    = MAX[ |VzOrg|, MIN(|Ve2|,Ve1) ]  =      57.703 kN.

 ==============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY.
 ==============================================================================

      ( ). Compute shear strength of concrete.
          -. Vu     =       57.70 kN.
          -. Vc     = 0.17*SQRT(fc)*bw*d =       97.15 kN.
          -. phi    = 0.75
          -. phiVc  = phi*Vc             =       72.86 kN.
          -. phiVc/2 < Vu < phiVc  --->  Minimum shear reinforcement is required.

      ( ). Compute required shear reinforcement. ( Av1 =  0.00007 m^2. )
          -. Avmin1 = 0.35*bw/fys           =2.500e-04 m^2/m.
          -. Avmin2 = 0.062*SQRT(fc)*bw/fys =2.343e-04 m^2/m.
          -. Av     = MAX[ Avmin1, Avmin2 ] =2.500e-04 m^2/m.
          -. N_leg  =  2
          -. Calculate spacing s1 = N_leg*Av1 / Av         =    0.568 m.
          -. Applied spacing s    = MIN[ s1, d/2, 600 mm ] =    0.180 m.
```

PROJECT TITLE : Acueducto Agua Bonita San José del Guaviare

	Company	Leandro Castellanos	Client	
	Author	Leandro Castellanos	File Name	Tanque Elevado.rcs

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-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
=========================================================================================

      *.midas Gen - RC-BEAM Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = BEAM,   MEMB = 14319

      *.DESCRIPTION OF BEAM DATA (iSEC =     2) : V30*40
        Section Type : Rectangle (RECT)
        Beam Length (Span)            =         2.950 m.
        Section Depth (Hc)            =         0.400 m.
        Section Width (Bc)            =         0.300 m.
        Concrete Strength (fc)        =     28000.000 KPa.
        Modulus of Elasticity (Ec)    =  24870062.324 KPa.
        Main Rebar Strength (fy)      =    420000.000 KPa.
        Stirrups Strength (fys)       =    420000.000 KPa.
        Modulus of Elasticity (Es)    = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

      *.FORCES AND MOMENTS AT CHECK POINT <I> :
        Positive Bending Moment   P-Mu =       64.19 kN-m.,  LCB =  25
        Negative Bending Moment   N-Mu =       65.53 kN-m.,  LCB =  19
        Shear Force                Vu  =       55.68 kN.  ,  LCB =  19

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------
           Location    i     di( m.)       Rebar    Asi( m^2.)
        ---------------------------------------------------------
           Top         1      0.040         4-#4      0.00052
           Bottom      2      0.360         4-#4      0.00052
        ---------------------------------------------------------
           Stirrups : #3

 ===============================================================================
    [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ===============================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy            =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.073 m. < smax  --->  O.K.
```

```
--------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                 Gen 2022
======================================================================================


      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0061
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0048
           -. Rhomin < Rho < Rhomax  --->  O.K !

      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.030 m.
           -. Mn     = As*fy*(d-a/2)      =       74.75 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       67.27 kN-m.

      ( ). Check ratio of positive moment capacity.
           -. Rat_P  = Mu/phiMn =    0.954  <  1.000  --->  O.K.

 ===============================================================================
    [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
 ===============================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.073 m. < smax  --->  O.K.

      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0062
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0048
           -. Rhomin < Rho < Rhomax  --->  O.K !
```

```
-------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                    Gen 2022
===========================================================================================


      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.030 m.
           -. Mn     = As*fy*(d-a/2)      =       74.75 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       67.27 kN-m.

      ( ). Check ratio of negative moment capacity.
           -. Rat_N  = Mu/phiMn =    0.974  <  1.000  --->  O.K.

 ================================================================================
    [[[*]]]   CALCULATE DATA OF SPECIAL PROVISIONS FOR SEISMIC DESIGN.
 ================================================================================

      ( ). Design parameters.
           -. fy  = 420000.00000 KPa.
           -. phi    = 1.0

      ( ). Calculate bending strength for design shear force(I, Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.I+ = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate bending strength for design shear force(J, Clockwise)
           -. Ast    =      0.0006 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0334 m.
           -. Mn.J- = Ast*fy*(d-a/2)  =       81.861 kN-m.

      ( ). Calculate bending strength for design shear force(I, Counter-Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.I- = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate bending strength for design shear force(J, Counter-Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.J+ = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate design shear force according to special provisions for seismic design.
           -. Alpha1  = 1.0000
           -. Span    =      2.5000 m.(Net Length)
           -. VzG     =      -4.236 kN.  (by Gravity-Direction Load).
```

```
-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                 Gen 2022
=========================================================================================

          -. Clockwise
             Ve11_CW = VzG + Alpha1*(Mn.I+ + Mn.J-)/Span =      58.407 kN.
             Ve12_CW = VzG - Alpha1*(Mn.I+ + Mn.J-)/Span =     -66.880 kN.
             Ve1_CW  = MAX[ |Ve11_CW|, |Ve12_CW| ] =      66.880 kN.
          -. Counter-Clockwise
             Ve11_CCW= VzG + Alpha1*(Mn.I- + Mn.J+)/Span =      55.562 kN.
             Ve12_CCW= VzG - Alpha1*(Mn.I- + Mn.J+)/Span =     -64.035 kN.
             Ve1_CCW = MAX[ |Ve11_CCW|, |Ve12_CCW| ] =      64.035 kN.

          -. Ve1     = MAX[ |Ve1_CW|, |Ve1_CCW| ]  =      66.880 kN.
          -. VzOrg   =     -55.676 kN.  (by Analysis).
          -. Ve2     =      55.676 kN.  (by Applied Alpha2).
          -.   Vu    = MAX[ |VzOrg|, MIN(|Ve2|,Ve1) ]  =      55.676 kN.

 ===============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY.
 ===============================================================================

      ( ). Compute shear strength of concrete.
          -. Vu     =       55.68 kN.
          -. Vc     = 0.17*SQRT(fc)*bw*d =       97.15 kN.
          -. phi    = 0.75
          -. phiVc  = phi*Vc             =       72.86 kN.
          -. phiVc/2 < Vu < phiVc  --->  Minimum shear reinforcement is required.

      ( ). Compute required shear reinforcement. ( Av1 =  0.00007 m^2. )
          -. Avmin1 = 0.35*bw/fys           =2.500e-04 m^2/m.
          -. Avmin2 = 0.062*SQRT(fc)*bw/fys =2.343e-04 m^2/m.
          -. Av     = MAX[ Avmin1, Avmin2 ] =2.500e-04 m^2/m.
          -. N_leg  =  2
          -. Calculate spacing s1 = N_leg*Av1 / Av         =    0.568 m.
          -. Applied spacing s    = MIN[ s1, d/2, 600 mm ] =    0.180 m.
```

```
---------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                 Gen 2022
=============================================================================================

      *.midas Gen - RC-BEAM Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = BEAM,   MEMB = 14321

      *.DESCRIPTION OF BEAM DATA (iSEC =     3) : V40*40
        Section Type : Rectangle (RECT)
        Beam Length (Span)            =        2.950 m.
        Section Depth (Hc)            =        0.400 m.
        Section Width (Bc)            =        0.400 m.
        Concrete Strength (fc)        =    28000.000 KPa.
        Modulus of Elasticity (Ec)    =  24870062.324 KPa.
        Main Rebar Strength (fy)      =   420000.000 KPa.
        Stirrups Strength (fys)       =   420000.000 KPa.
        Modulus of Elasticity (Es)    = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

      *.FORCES AND MOMENTS AT CHECK POINT <I> :
        Positive Bending Moment   P-Mu =       2.92 kN-m.,  LCB =  12
        Negative Bending Moment   N-Mu =       5.26 kN-m.,  LCB =  19
        Shear Force                Vu  =      41.29 kN.  ,  LCB =  19

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------
           Location    i     di( m.)       Rebar    Asi( m^2.)
        ---------------------------------------------------------
           Top         1      0.040         3-#4      0.00039
           Bottom      2      0.360         3-#4      0.00039
        ---------------------------------------------------------
           Stirrups : #3

 ===============================================================================
    [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ===============================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy            =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.160 m. < smax  --->  O.K.
```

```
------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
==========================================================================================


      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0002
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0002
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0027
           -. Rhomin < Rho < Rhomax  --->  O.K !

      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.017 m.
           -. Mn     = As*fy*(d-a/2)      =       57.14 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       51.43 kN-m.

      ( ). Check ratio of positive moment capacity.
           -. Rat_P  = Mu/phiMn =    0.057  <  1.000  --->  O.K.

 ================================================================================
    [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
 ================================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.160 m. < smax  --->  O.K.

      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0004
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0004
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0027
           -. Rhomin < Rho < Rhomax  --->  O.K !
```

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------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
==========================================================================================


      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.017 m.
           -. Mn     = As*fy*(d-a/2)      =       57.14 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       51.43 kN-m.

      ( ). Check ratio of negative moment capacity.
           -. Rat_N  = Mu/phiMn =    0.102  <  1.000  --->  O.K.

 ================================================================================
    [[[*]]]   CALCULATE DATA OF SPECIAL PROVISIONS FOR SEISMIC DESIGN.
 ================================================================================

      ( ). Design parameters.
           -. fy  = 420000.00000 KPa.
           -. phi    = 1.0

      ( ). Calculate bending strength for design shear force(I, Clockwise)
           -. Ast    =      0.0004 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0171 m.
           -. Mn.I+ = Ast*fy*(d-a/2)  =       57.141 kN-m.

      ( ). Calculate bending strength for design shear force(J, Clockwise)
           -. Ast    =      0.0004 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0171 m.
           -. Mn.J- = Ast*fy*(d-a/2)  =       57.141 kN-m.

      ( ). Calculate bending strength for design shear force(I, Counter-Clockwise)
           -. Ast    =      0.0004 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0171 m.
           -. Mn.I- = Ast*fy*(d-a/2)  =       57.141 kN-m.

      ( ). Calculate bending strength for design shear force(J, Counter-Clockwise)
           -. Ast    =      0.0004 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0171 m.
           -. Mn.J+ = Ast*fy*(d-a/2)  =       57.141 kN-m.

      ( ). Calculate design shear force according to special provisions for seismic design.
           -. Alpha1  = 1.0000
           -. Span    =      2.9500 m.
           -. VzG     =     -19.015 kN.  (by Gravity-Direction Load).
```

```
----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
========================================================================================

           -. Clockwise
              Ve11_CW = VzG + Alpha1*(Mn.I+ + Mn.J-)/Span =      19.724 kN.
              Ve12_CW = VzG - Alpha1*(Mn.I+ + Mn.J-)/Span =     -57.755 kN.
              Ve1_CW  = MAX[ |Ve11_CW|, |Ve12_CW| ] =      57.755 kN.
           -. Counter-Clockwise
              Ve11_CCW= VzG + Alpha1*(Mn.I- + Mn.J+)/Span =      19.724 kN.
              Ve12_CCW= VzG - Alpha1*(Mn.I- + Mn.J+)/Span =     -57.755 kN.
              Ve1_CCW = MAX[ |Ve11_CCW|, |Ve12_CCW| ] =      57.755 kN.

           -. Ve1     = MAX[ |Ve1_CW|, |Ve1_CCW| ]  =      57.755 kN.
           -. VzOrg   =     -41.291 kN.  (by Analysis).
           -. Ve2     =      41.291 kN.  (by Applied Alpha2).
           -.   Vu    = MAX[ |VzOrg|, MIN(|Ve2|,Ve1) ]  =      41.291 kN.

 ==============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY.
 ==============================================================================

      ( ). Compute shear strength of concrete.
           -. Vu     =       41.29 kN.
           -. Vc     = 0.17*SQRT(fc)*bw*d =      129.54 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc             =       97.15 kN.
           -. Vu < phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute required shear reinforcement.
           -. Applied spacing s    = MIN[ d/2, 600 mm ] =    0.180 m.
```

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------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                    Gen 2022
==========================================================================================

      *.midas Gen - RC-BEAM Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = BEAM,   MEMB = 14323

      *.DESCRIPTION OF BEAM DATA (iSEC =     2) : V30*40
        Section Type : Rectangle (RECT)
        Beam Length (Span)          =         2.950 m.
        Section Depth (Hc)          =         0.400 m.
        Section Width (Bc)          =         0.300 m.
        Concrete Strength (fc)      =     28000.000 KPa.
        Modulus of Elasticity (Ec)  =  24870062.324 KPa.
        Main Rebar Strength (fy)    =    420000.000 KPa.
        Stirrups Strength (fys)     =    420000.000 KPa.
        Modulus of Elasticity (Es)  = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

      *.FORCES AND MOMENTS AT CHECK POINT <I> :
        Positive Bending Moment   P-Mu =       64.24 kN-m.,  LCB =  28
        Negative Bending Moment   N-Mu =       67.50 kN-m.,  LCB =  22
        Shear Force                Vu  =       57.69 kN.  ,  LCB =  22

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------
           Location    i     di( m.)       Rebar    Asi( m^2.)
        ---------------------------------------------------------
           Top         1      0.040         2-#6      0.00057
           Bottom      2      0.360         4-#4      0.00052
        ---------------------------------------------------------
           Stirrups : #3

 ================================================================================
    [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ================================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.073 m. < smax  --->  O.K.
```

```
------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
==========================================================================================


      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0061
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0048
           -. Rhomin < Rho < Rhomax  --->  O.K !

      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.030 m.
           -. Mn     = As*fy*(d-a/2)      =       74.75 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       67.27 kN-m.

      ( ). Check ratio of positive moment capacity.
           -. Rat_P  = Mu/phiMn =    0.955  <  1.000  --->  O.K.

 ===================================================================================
    [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
 ===================================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.030 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.304 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.300 m.
           -. s    =    0.220 m. < smax  --->  O.K.

      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0064
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0053
           -. Rhomin < Rho < Rhomax  --->  O.K !
```

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------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                        Gen 2022
==========================================================================================


      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.033 m.
           -. Mn     = As*fy*(d-a/2)      =       81.86 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       73.67 kN-m.

      ( ). Check ratio of negative moment capacity.
           -. Rat_N  = Mu/phiMn =    0.916  <  1.000  --->  O.K.

 ================================================================================
    [[[*]]]   CALCULATE DATA OF SPECIAL PROVISIONS FOR SEISMIC DESIGN.
 ================================================================================

      ( ). Design parameters.
           -. fy  = 420000.00000 KPa.
           -. phi    = 1.0

      ( ). Calculate bending strength for design shear force(I, Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.I+ = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate bending strength for design shear force(J, Clockwise)
           -. Ast    =      0.0006 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0334 m.
           -. Mn.J- = Ast*fy*(d-a/2)  =       81.861 kN-m.

      ( ). Calculate bending strength for design shear force(I, Counter-Clockwise)
           -. Ast    =      0.0006 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0334 m.
           -. Mn.I- = Ast*fy*(d-a/2)  =       81.861 kN-m.

      ( ). Calculate bending strength for design shear force(J, Counter-Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.J+ = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate design shear force according to special provisions for seismic design.
           -. Alpha1  = 1.0000
           -. Span    =      2.5000 m.(Net Length)
           -. VzG     =      -4.689 kN.  (by Gravity-Direction Load).
```

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-------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
===========================================================================================

           -. Clockwise
              Ve11_CW = VzG + Alpha1*(Mn.I+ + Mn.J-)/Span =      57.955 kN.
              Ve12_CW = VzG - Alpha1*(Mn.I+ + Mn.J-)/Span =     -67.332 kN.
              Ve1_CW  = MAX[ |Ve11_CW|, |Ve12_CW| ] =      67.332 kN.
           -. Counter-Clockwise
              Ve11_CCW= VzG + Alpha1*(Mn.I- + Mn.J+)/Span =      57.955 kN.
              Ve12_CCW= VzG - Alpha1*(Mn.I- + Mn.J+)/Span =     -67.332 kN.
              Ve1_CCW = MAX[ |Ve11_CCW|, |Ve12_CCW| ] =      67.332 kN.

           -. Ve1     = MAX[ |Ve1_CW|, |Ve1_CCW| ]  =      67.332 kN.
           -. VzOrg   =     -57.694 kN.  (by Analysis).
           -. Ve2     =      57.694 kN.  (by Applied Alpha2).
           -.   Vu    = MAX[ |VzOrg|, MIN(|Ve2|,Ve1) ]  =      57.694 kN.

 ===============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY.
 ===============================================================================

      ( ). Compute shear strength of concrete.
           -. Vu     =       57.69 kN.
           -. Vc     = 0.17*SQRT(fc)*bw*d =       97.15 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc             =       72.86 kN.
           -. phiVc/2 < Vu < phiVc  --->  Minimum shear reinforcement is required.

      ( ). Compute required shear reinforcement. ( Av1 =  0.00007 m^2. )
           -. Avmin1 = 0.35*bw/fys           =2.500e-04 m^2/m.
           -. Avmin2 = 0.062*SQRT(fc)*bw/fys =2.343e-04 m^2/m.
           -. Av     = MAX[ Avmin1, Avmin2 ] =2.500e-04 m^2/m.
           -. N_leg  =  2
           -. Calculate spacing s1 = N_leg*Av1 / Av         =    0.568 m.
           -. Applied spacing s    = MIN[ s1, d/2, 600 mm ] =    0.180 m.
```

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-------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
===========================================================================================

      *.midas Gen - RC-BEAM Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = BEAM,   MEMB = 14325

      *.DESCRIPTION OF BEAM DATA (iSEC =     2) : V30*40
        Section Type : Rectangle (RECT)
        Beam Length (Span)            =        2.950 m.
        Section Depth (Hc)            =        0.400 m.
        Section Width (Bc)            =        0.300 m.
        Concrete Strength (fc)        =    28000.000 KPa.
        Modulus of Elasticity (Ec)    =  24870062.324 KPa.
        Main Rebar Strength (fy)      =   420000.000 KPa.
        Stirrups Strength (fys)       =   420000.000 KPa.
        Modulus of Elasticity (Es)    = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

      *.FORCES AND MOMENTS AT CHECK POINT <I> :
        Positive Bending Moment   P-Mu =       64.19 kN-m.,  LCB =  25
        Negative Bending Moment   N-Mu =       65.50 kN-m.,  LCB =  19
        Shear Force                Vu  =       55.65 kN.  ,  LCB =  19

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------
           Location    i     di( m.)       Rebar    Asi( m^2.)
        ---------------------------------------------------------
           Top         1      0.040         4-#4      0.00052
           Bottom      2      0.360         4-#4      0.00052
        ---------------------------------------------------------
           Stirrups : #3

 ===============================================================================
    [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ===============================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.073 m. < smax  --->  O.K.
```

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------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
==========================================================================================


      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0061
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0048
           -. Rhomin < Rho < Rhomax  --->  O.K !

      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.030 m.
           -. Mn     = As*fy*(d-a/2)      =       74.75 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       67.27 kN-m.

      ( ). Check ratio of positive moment capacity.
           -. Rat_P  = Mu/phiMn =    0.954  <  1.000  --->  O.K.

 ================================================================================
    [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
 ================================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500  ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.073 m. < smax  --->  O.K.

      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0062
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0048
           -. Rhomin < Rho < Rhomax  --->  O.K !
```

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--------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
============================================================================================


      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.030 m.
           -. Mn     = As*fy*(d-a/2)      =       74.75 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       67.27 kN-m.

      ( ). Check ratio of negative moment capacity.
           -. Rat_N  = Mu/phiMn =    0.974  <  1.000  --->  O.K.

 ===============================================================================
    [[[*]]]   CALCULATE DATA OF SPECIAL PROVISIONS FOR SEISMIC DESIGN.
 ===============================================================================

      ( ). Design parameters.
           -. fy  = 420000.00000 KPa.
           -. phi    = 1.0

      ( ). Calculate bending strength for design shear force(I, Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.I+ = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate bending strength for design shear force(J, Clockwise)
           -. Ast    =      0.0006 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0334 m.
           -. Mn.J- = Ast*fy*(d-a/2)  =       81.861 kN-m.

      ( ). Calculate bending strength for design shear force(I, Counter-Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.I- = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate bending strength for design shear force(J, Counter-Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.J+ = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate design shear force according to special provisions for seismic design.
           -. Alpha1  = 1.0000
           -. Span    =      2.5000 m.(Net Length)
           -. VzG     =      -4.225 kN.  (by Gravity-Direction Load).
```

```
------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
==========================================================================================

          -. Clockwise
             Ve11_CW = VzG + Alpha1*(Mn.I+ + Mn.J-)/Span =      58.418 kN.
             Ve12_CW = VzG - Alpha1*(Mn.I+ + Mn.J-)/Span =     -66.869 kN.
             Ve1_CW  = MAX[ |Ve11_CW|, |Ve12_CW| ] =      66.869 kN.
          -. Counter-Clockwise
             Ve11_CCW= VzG + Alpha1*(Mn.I- + Mn.J+)/Span =      55.573 kN.
             Ve12_CCW= VzG - Alpha1*(Mn.I- + Mn.J+)/Span =     -64.023 kN.
             Ve1_CCW = MAX[ |Ve11_CCW|, |Ve12_CCW| ] =      64.023 kN.

          -. Ve1     = MAX[ |Ve1_CW|, |Ve1_CCW| ]  =      66.869 kN.
          -. VzOrg   =     -55.652 kN.  (by Analysis).
          -. Ve2     =      55.652 kN.  (by Applied Alpha2).
          -.   Vu    = MAX[ |VzOrg|, MIN(|Ve2|,Ve1) ]  =      55.652 kN.

 ===============================================================================
   [[[*]]]   ANALYZE SHEAR CAPACITY.
 ===============================================================================

      ( ). Compute shear strength of concrete.
          -. Vu      =       55.65 kN.
          -. Vc      = 0.17*SQRT(fc)*bw*d =       97.15 kN.
          -. phi     = 0.75
          -. phiVc   = phi*Vc              =       72.86 kN.
          -. phiVc/2 < Vu < phiVc  --->  Minimum shear reinforcement is required.

      ( ). Compute required shear reinforcement. ( Av1 =  0.00007 m^2. )
          -. Avmin1 = 0.35*bw/fys           =2.500e-04 m^2/m.
          -. Avmin2 = 0.062*SQRT(fc)*bw/fys =2.343e-04 m^2/m.
          -. Av     = MAX[ Avmin1, Avmin2 ] =2.500e-04 m^2/m.
          -. N_leg  =  2
          -. Calculate spacing s1 = N_leg*Av1 / Av         =    0.568 m.
          -. Applied spacing s    = MIN[ s1, d/2, 600 mm ] =    0.180 m.
```

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-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
=========================================================================================

      *.midas Gen - RC-BEAM Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = BEAM,   MEMB = 14327

      *.DESCRIPTION OF BEAM DATA (iSEC =     3) : V40*40
        Section Type : Rectangle (RECT)
        Beam Length (Span)            =        2.950 m.
        Section Depth (Hc)            =        0.400 m.
        Section Width (Bc)            =        0.400 m.
        Concrete Strength (fc)        =    28000.000 KPa.
        Modulus of Elasticity (Ec)    =  24870062.324 KPa.
        Main Rebar Strength (fy)      =   420000.000 KPa.
        Stirrups Strength (fys)       =   420000.000 KPa.
        Modulus of Elasticity (Es)    = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

      *.FORCES AND MOMENTS AT CHECK POINT <I> :
        Positive Bending Moment   P-Mu =        2.95 kN-m.,  LCB =  12
        Negative Bending Moment   N-Mu =        5.24 kN-m.,  LCB =  19
        Shear Force                Vu  =       41.36 kN.  ,  LCB =  19

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------
           Location    i     di( m.)       Rebar    Asi( m^2.)
        ---------------------------------------------------------
           Top         1      0.040         3-#4      0.00039
           Bottom      2      0.360         3-#4      0.00039
        ---------------------------------------------------------
           Stirrups : #3

 ===============================================================================
   [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ===============================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy              =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.160 m. < smax  --->  O.K.
```

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-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
=========================================================================================


      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0002
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0002
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0027
           -. Rhomin < Rho < Rhomax  --->  O.K !

      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.017 m.
           -. Mn     = As*fy*(d-a/2)      =       57.14 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       51.43 kN-m.

      ( ). Check ratio of positive moment capacity.
           -. Rat_P  = Mu/phiMn =    0.057  <  1.000  --->  O.K.

 ===============================================================================
    [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
 ===============================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.160 m. < smax  --->  O.K.

      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0004
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0004
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0027
           -. Rhomin < Rho < Rhomax  --->  O.K !
```

```
--------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                 Gen 2022
============================================================================================


      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.017 m.
           -. Mn     = As*fy*(d-a/2)      =       57.14 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       51.43 kN-m.

      ( ). Check ratio of negative moment capacity.
           -. Rat_N  = Mu/phiMn =    0.102  <  1.000  --->  O.K.

 ================================================================================
    [[[*]]]   CALCULATE DATA OF SPECIAL PROVISIONS FOR SEISMIC DESIGN.
 ================================================================================

      ( ). Design parameters.
           -. fy  = 420000.00000 KPa.
           -. phi    = 1.0

      ( ). Calculate bending strength for design shear force(I, Clockwise)
           -. Ast    =      0.0004 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0171 m.
           -. Mn.I+ = Ast*fy*(d-a/2)  =       57.141 kN-m.

      ( ). Calculate bending strength for design shear force(J, Clockwise)
           -. Ast    =      0.0004 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0171 m.
           -. Mn.J- = Ast*fy*(d-a/2)  =       57.141 kN-m.

      ( ). Calculate bending strength for design shear force(I, Counter-Clockwise)
           -. Ast    =      0.0004 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0171 m.
           -. Mn.I- = Ast*fy*(d-a/2)  =       57.141 kN-m.

      ( ). Calculate bending strength for design shear force(J, Counter-Clockwise)
           -. Ast    =      0.0004 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0171 m.
           -. Mn.J+ = Ast*fy*(d-a/2)  =       57.141 kN-m.

      ( ). Calculate design shear force according to special provisions for seismic design.
           -. Alpha1  = 1.0000
           -. Span    =      2.9500 m.
           -. VzG     =     -19.110 kN.  (by Gravity-Direction Load).
```

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-------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                 Gen 2022
===========================================================================================

          -. Clockwise
             Ve11_CW = VzG + Alpha1*(Mn.I+ + Mn.J-)/Span =      19.629 kN.
             Ve12_CW = VzG - Alpha1*(Mn.I+ + Mn.J-)/Span =     -57.850 kN.
             Ve1_CW  = MAX[ |Ve11_CW|, |Ve12_CW| ] =      57.850 kN.
          -. Counter-Clockwise
             Ve11_CCW= VzG + Alpha1*(Mn.I- + Mn.J+)/Span =      19.629 kN.
             Ve12_CCW= VzG - Alpha1*(Mn.I- + Mn.J+)/Span =     -57.850 kN.
             Ve1_CCW = MAX[ |Ve11_CCW|, |Ve12_CCW| ] =      57.850 kN.

          -. Ve1     = MAX[ |Ve1_CW|, |Ve1_CCW| ]  =      57.850 kN.
          -. VzOrg   =     -41.358 kN.  (by Analysis).
          -. Ve2     =      41.358 kN.  (by Applied Alpha2).
          -.   Vu    = MAX[ |VzOrg|, MIN(|Ve2|,Ve1) ]  =      41.358 kN.

 ===============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY.
 ===============================================================================

      ( ). Compute shear strength of concrete.
          -. Vu     =       41.36 kN.
          -. Vc     = 0.17*SQRT(fc)*bw*d =      129.54 kN.
          -. phi    = 0.75
          -. phiVc  = phi*Vc             =       97.15 kN.
          -. Vu < phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute required shear reinforcement.
          -. Applied spacing s    = MIN[ d/2, 600 mm ] =    0.180 m.
```

```
-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
=========================================================================================

      *.midas Gen - RC-BEAM Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = BEAM,   MEMB = 14329

      *.DESCRIPTION OF BEAM DATA (iSEC =     2) : V30*40
        Section Type : Rectangle (RECT)
        Beam Length (Span)            =         2.950 m.
        Section Depth (Hc)            =         0.400 m.
        Section Width (Bc)            =         0.300 m.
        Concrete Strength (fc)        =     28000.000 KPa.
        Modulus of Elasticity (Ec)    =  24870062.324 KPa.
        Main Rebar Strength (fy)      =    420000.000 KPa.
        Stirrups Strength (fys)       =    420000.000 KPa.
        Modulus of Elasticity (Es)    = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

      *.FORCES AND MOMENTS AT CHECK POINT <I> :
        Positive Bending Moment   P-Mu =       64.34 kN-m.,  LCB =  28
        Negative Bending Moment   N-Mu =       67.42 kN-m.,  LCB =  22
        Shear Force                Vu  =       57.65 kN.  ,  LCB =  22

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------
           Location    i     di( m.)       Rebar    Asi( m^2.)
        ---------------------------------------------------------
           Top         1      0.040         2-#6      0.00057
           Bottom      2      0.360         4-#4      0.00052
        ---------------------------------------------------------
           Stirrups : #3

 ===============================================================================
   [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ===============================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy            =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.073 m. < smax  --->  O.K.
```

```
-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                 Gen 2022
=========================================================================================


      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0061
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0048
           -. Rhomin < Rho < Rhomax  --->  O.K !

      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.030 m.
           -. Mn     = As*fy*(d-a/2)      =       74.75 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       67.27 kN-m.

      ( ). Check ratio of positive moment capacity.
           -. Rat_P  = Mu/phiMn =    0.956  <  1.000  --->  O.K.

 ===============================================================================
    [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
 ===============================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500  ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.030 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.304 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.300 m.
           -. s    =    0.220 m. < smax  --->  O.K.

      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0064
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0053
           -. Rhomin < Rho < Rhomax  --->  O.K !
```

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-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                 Gen 2022
=========================================================================================


      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.033 m.
           -. Mn     = As*fy*(d-a/2)      =       81.86 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       73.67 kN-m.

      ( ). Check ratio of negative moment capacity.
           -. Rat_N  = Mu/phiMn =    0.915  <  1.000  --->  O.K.

 ===============================================================================
    [[[*]]]   CALCULATE DATA OF SPECIAL PROVISIONS FOR SEISMIC DESIGN.
 ===============================================================================

      ( ). Design parameters.
           -. fy  = 420000.00000 KPa.
           -. phi    = 1.0

      ( ). Calculate bending strength for design shear force(I, Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.I+ = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate bending strength for design shear force(J, Clockwise)
           -. Ast    =      0.0006 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0334 m.
           -. Mn.J- = Ast*fy*(d-a/2)  =       81.861 kN-m.

      ( ). Calculate bending strength for design shear force(I, Counter-Clockwise)
           -. Ast    =      0.0006 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0334 m.
           -. Mn.I- = Ast*fy*(d-a/2)  =       81.861 kN-m.

      ( ). Calculate bending strength for design shear force(J, Counter-Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.J+ = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate design shear force according to special provisions for seismic design.
           -. Alpha1  = 1.0000
           -. Span    =      2.5000 m.(Net Length)
           -. VzG     =      -4.651 kN.  (by Gravity-Direction Load).
```

```
-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                 Gen 2022
=========================================================================================

           -. Clockwise
              Ve11_CW = VzG + Alpha1*(Mn.I+ + Mn.J-)/Span =      57.992 kN.
              Ve12_CW = VzG - Alpha1*(Mn.I+ + Mn.J-)/Span =     -67.295 kN.
              Ve1_CW  = MAX[ |Ve11_CW|, |Ve12_CW| ] =      67.295 kN.
           -. Counter-Clockwise
              Ve11_CCW= VzG + Alpha1*(Mn.I- + Mn.J+)/Span =      57.992 kN.
              Ve12_CCW= VzG - Alpha1*(Mn.I- + Mn.J+)/Span =     -67.295 kN.
              Ve1_CCW = MAX[ |Ve11_CCW|, |Ve12_CCW| ] =      67.295 kN.

           -. Ve1     = MAX[ |Ve1_CW|, |Ve1_CCW| ]  =      67.295 kN.
           -. VzOrg   =     -57.648 kN.  (by Analysis).
           -. Ve2     =      57.648 kN.  (by Applied Alpha2).
           -.   Vu    = MAX[ |VzOrg|, MIN(|Ve2|,Ve1) ]  =      57.648 kN.

 ===============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY.
 ===============================================================================

      ( ). Compute shear strength of concrete.
           -. Vu     =       57.65 kN.
           -. Vc     = 0.17*SQRT(fc)*bw*d =       97.15 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc             =       72.86 kN.
           -. phiVc/2 < Vu < phiVc  --->  Minimum shear reinforcement is required.

      ( ). Compute required shear reinforcement. ( Av1 =  0.00007 m^2. )
           -. Avmin1 = 0.35*bw/fys           =2.500e-04 m^2/m.
           -. Avmin2 = 0.062*SQRT(fc)*bw/fys =2.343e-04 m^2/m.
           -. Av     = MAX[ Avmin1, Avmin2 ] =2.500e-04 m^2/m.
           -. N_leg  =  2
           -. Calculate spacing s1 = N_leg*Av1 / Av         =    0.568 m.
           -. Applied spacing s    = MIN[ s1, d/2, 600 mm ] =    0.180 m.
```

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-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
=========================================================================================

      *.midas Gen - RC-BEAM Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = BEAM,   MEMB = 14331

      *.DESCRIPTION OF BEAM DATA (iSEC =     2) : V30*40
        Section Type : Rectangle (RECT)
        Beam Length (Span)          =         2.950 m.
        Section Depth (Hc)          =         0.400 m.
        Section Width (Bc)          =         0.300 m.
        Concrete Strength (fc)      =     28000.000 KPa.
        Modulus of Elasticity (Ec)  =  24870062.324 KPa.
        Main Rebar Strength (fy)    =    420000.000 KPa.
        Stirrups Strength (fys)     =    420000.000 KPa.
        Modulus of Elasticity (Es)  = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

      *.FORCES AND MOMENTS AT CHECK POINT <I> :
        Positive Bending Moment   P-Mu =       64.30 kN-m.,  LCB =  25
        Negative Bending Moment   N-Mu =       65.34 kN-m.,  LCB =  19
        Shear Force                Vu  =       55.48 kN.  ,  LCB =  19

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------
           Location    i     di( m.)       Rebar    Asi( m^2.)
        ---------------------------------------------------------
           Top         1      0.040         4-#4      0.00052
           Bottom      2      0.360         4-#4      0.00052
        ---------------------------------------------------------
           Stirrups : #3

 ===============================================================================
    [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ===============================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.073 m. < smax  --->  O.K.
```

```
-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                    Gen 2022
=========================================================================================


      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0061
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0048
           -. Rhomin < Rho < Rhomax  --->  O.K !

      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.030 m.
           -. Mn     = As*fy*(d-a/2)      =       74.75 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       67.27 kN-m.

      ( ). Check ratio of positive moment capacity.
           -. Rat_P  = Mu/phiMn =    0.956  <  1.000  --->  O.K.

 ===============================================================================
    [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
 ===============================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500  ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.073 m. < smax  --->  O.K.

      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0062
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0048
           -. Rhomin < Rho < Rhomax  --->  O.K !
```

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-------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                   Gen 2022
===========================================================================================


      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.030 m.
           -. Mn     = As*fy*(d-a/2)      =       74.75 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       67.27 kN-m.

      ( ). Check ratio of negative moment capacity.
           -. Rat_N  = Mu/phiMn =    0.971  <  1.000  --->  O.K.

 ================================================================================
    [[[*]]]   CALCULATE DATA OF SPECIAL PROVISIONS FOR SEISMIC DESIGN.
 ================================================================================

      ( ). Design parameters.
           -. fy  = 420000.00000 KPa.
           -. phi    = 1.0

      ( ). Calculate bending strength for design shear force(I, Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.I+ = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate bending strength for design shear force(J, Clockwise)
           -. Ast    =      0.0006 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0334 m.
           -. Mn.J- = Ast*fy*(d-a/2)  =       81.861 kN-m.

      ( ). Calculate bending strength for design shear force(I, Counter-Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.I- = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate bending strength for design shear force(J, Counter-Clockwise)
           -. Ast    =      0.0005 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0304 m.
           -. Mn.J+ = Ast*fy*(d-a/2)  =       74.748 kN-m.

      ( ). Calculate design shear force according to special provisions for seismic design.
           -. Alpha1  = 1.0000
           -. Span    =      2.5000 m.(Net Length)
           -. VzG     =      -4.131 kN.  (by Gravity-Direction Load).
```

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---------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                Gen 2022
=======================================================================================

          -. Clockwise
             Ve11_CW = VzG + Alpha1*(Mn.I+ + Mn.J-)/Span =      58.512 kN.
             Ve12_CW = VzG - Alpha1*(Mn.I+ + Mn.J-)/Span =     -66.775 kN.
             Ve1_CW  = MAX[ |Ve11_CW|, |Ve12_CW| ] =      66.775 kN.
          -. Counter-Clockwise
             Ve11_CCW= VzG + Alpha1*(Mn.I- + Mn.J+)/Span =      55.667 kN.
             Ve12_CCW= VzG - Alpha1*(Mn.I- + Mn.J+)/Span =     -63.930 kN.
             Ve1_CCW = MAX[ |Ve11_CCW|, |Ve12_CCW| ] =      63.930 kN.

          -. Ve1     = MAX[ |Ve1_CW|, |Ve1_CCW| ]  =      66.775 kN.
          -. VzOrg   =     -55.477 kN.  (by Analysis).
          -. Ve2     =      55.477 kN.  (by Applied Alpha2).
          -.   Vu    = MAX[ |VzOrg|, MIN(|Ve2|,Ve1) ]  =      55.477 kN.

 ===============================================================================
   [[[*]]]   ANALYZE SHEAR CAPACITY.
 ===============================================================================

      ( ). Compute shear strength of concrete.
          -. Vu     =       55.48 kN.
          -. Vc     = 0.17*SQRT(fc)*bw*d =       97.15 kN.
          -. phi    = 0.75
          -. phiVc  = phi*Vc             =       72.86 kN.
          -. phiVc/2 < Vu < phiVc  --->  Minimum shear reinforcement is required.

      ( ). Compute required shear reinforcement. ( Av1 =  0.00007 m^2. )
          -. Avmin1 = 0.35*bw/fys           =2.500e-04 m^2/m.
          -. Avmin2 = 0.062*SQRT(fc)*bw/fys =2.343e-04 m^2/m.
          -. Av     = MAX[ Avmin1, Avmin2 ] =2.500e-04 m^2/m.
          -. N_leg  =  2
          -. Calculate spacing s1 = N_leg*Av1 / Av         =    0.568 m.
          -. Applied spacing s    = MIN[ s1, d/2, 600 mm ] =    0.180 m.
```

```
-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                   Gen 2022
=========================================================================================

      *.midas Gen - RC-BEAM Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = BEAM,   MEMB = 14333

      *.DESCRIPTION OF BEAM DATA (iSEC =     3) : V40*40
        Section Type : Rectangle (RECT)
        Beam Length (Span)            =        2.950 m.
        Section Depth (Hc)            =        0.400 m.
        Section Width (Bc)            =        0.400 m.
        Concrete Strength (fc)        =    28000.000 KPa.
        Modulus of Elasticity (Ec)    =  24870062.324 KPa.
        Main Rebar Strength (fy)      =   420000.000 KPa.
        Stirrups Strength (fys)       =   420000.000 KPa.
        Modulus of Elasticity (Es)    = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

      *.FORCES AND MOMENTS AT CHECK POINT <I> :
        Positive Bending Moment   P-Mu =       2.58 kN-m.,  LCB =  12
        Negative Bending Moment   N-Mu =      13.15 kN-m.,  LCB =  19
        Shear Force                Vu  =      71.98 kN.  ,  LCB =  19

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------
           Location    i     di( m.)       Rebar    Asi( m^2.)
        ---------------------------------------------------------
           Top         1      0.040         3-#4      0.00039
           Bottom      2      0.360         3-#4      0.00039
        ---------------------------------------------------------
           Stirrups : #3

 ================================================================================
   [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ================================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500  ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.160 m. < smax  --->  O.K.
```

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--------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
============================================================================================


      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0002
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0002
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0027
           -. Rhomin < Rho < Rhomax  --->  O.K !

      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.017 m.
           -. Mn     = As*fy*(d-a/2)      =       57.14 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       51.43 kN-m.

      ( ). Check ratio of positive moment capacity.
           -. Rat_P  = Mu/phiMn =    0.050  <  1.000  --->  O.K.

 ==================================================================================
    [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
 ==================================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.160 m. < smax  --->  O.K.

      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0009
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0009
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0206
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0206

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0027
           -. Rhomin < Rho < Rhomax  --->  O.K !
```

```
-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
=========================================================================================


      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.017 m.
           -. Mn     = As*fy*(d-a/2)      =       57.14 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       51.43 kN-m.

      ( ). Check ratio of negative moment capacity.
           -. Rat_N  = Mu/phiMn =    0.256  <  1.000  --->  O.K.

 ===============================================================================
    [[[*]]]   CALCULATE DATA OF SPECIAL PROVISIONS FOR SEISMIC DESIGN.
 ===============================================================================

      ( ). Design parameters.
           -. fy  = 420000.00000 KPa.
           -. phi    = 1.0

      ( ). Calculate bending strength for design shear force(I, Clockwise)
           -. Ast    =      0.0004 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0171 m.
           -. Mn.I+ = Ast*fy*(d-a/2)  =       57.141 kN-m.

      ( ). Calculate bending strength for design shear force(J, Clockwise)
           -. Ast    =      0.0004 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0171 m.
           -. Mn.J- = Ast*fy*(d-a/2)  =       57.141 kN-m.

      ( ). Calculate bending strength for design shear force(I, Counter-Clockwise)
           -. Ast    =      0.0004 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0171 m.
           -. Mn.I- = Ast*fy*(d-a/2)  =       57.141 kN-m.

      ( ). Calculate bending strength for design shear force(J, Counter-Clockwise)
           -. Ast    =      0.0004 m^2.
           -. d      =      0.3600 m.
           -. a      =      0.0171 m.
           -. Mn.J+ = Ast*fy*(d-a/2)  =       57.141 kN-m.

      ( ). Calculate design shear force according to special provisions for seismic design.
           -. Alpha1  = 1.0000
           -. Span    =      2.9500 m.
           -. VzG     =     -33.054 kN.  (by Gravity-Direction Load).
```

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 midas Gen - RC-Beam Design     [ NSR-10 ]                                 Gen 2022
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          -. Clockwise
             Ve11_CW = VzG + Alpha1*(Mn.I+ + Mn.J-)/Span =       5.686 kN.
             Ve12_CW = VzG - Alpha1*(Mn.I+ + Mn.J-)/Span =     -71.793 kN.
             Ve1_CW  = MAX[ |Ve11_CW|, |Ve12_CW| ] =      71.793 kN.
          -. Counter-Clockwise
             Ve11_CCW= VzG + Alpha1*(Mn.I- + Mn.J+)/Span =       5.686 kN.
             Ve12_CCW= VzG - Alpha1*(Mn.I- + Mn.J+)/Span =     -71.793 kN.
             Ve1_CCW = MAX[ |Ve11_CCW|, |Ve12_CCW| ] =      71.793 kN.

          -. Ve1     = MAX[ |Ve1_CW|, |Ve1_CCW| ]  =      71.793 kN.
          -. VzOrg   =     -71.984 kN.  (by Analysis).
          -. Ve2     =      71.984 kN.  (by Applied Alpha2).
          -.   Vu    = MAX[ |VzOrg|, MIN(|Ve2|,Ve1) ]  =      71.984 kN.

 ===============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY.
 ===============================================================================

      ( ). Compute shear strength of concrete.
          -. Vu      =       71.98 kN.
          -. Vc      = 0.17*SQRT(fc)*bw*d =      129.54 kN.
          -. phi     = 0.75
          -. phiVc   = phi*Vc             =       97.15 kN.
          -. phiVc/2 < Vu < phiVc  --->  Minimum shear reinforcement is required.

      ( ). Compute required shear reinforcement. ( Av1 =  0.00007 m^2. )
          -. Avmin1 = 0.35*bw/fys           =3.333e-04 m^2/m.
          -. Avmin2 = 0.062*SQRT(fc)*bw/fys =3.125e-04 m^2/m.
          -. Av     = MAX[ Avmin1, Avmin2 ] =3.333e-04 m^2/m.
          -. N_leg  =  2
          -. Calculate spacing s1 = N_leg*Av1 / Av         =    0.426 m.
          -. Applied spacing s    = MIN[ s1, d/2, 600 mm ] =    0.180 m.
```

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-------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
===========================================================================================


       +==============================================================+
       |  MIDAS(Modeling, Integrated Design & Analysis Software)      |
       |  midas Gen - Design & checking system for windows            |
       +==============================================================+
       |  RC-Member(Beam/Column/Brace/Wall) Analysis and Design       |
       |  Based On  Eurocode2:04, Eurocode2, ACI318-19,               |
       |            ACI318M-19, ACI318-14, ACI318M-14, ACI318-11,     |
       |            ACI318-08, ACI318-05, ACI318-02, ACI318-99,       |
       |            ACI318-95, ACI318-89, NSR-10, CSA-A23.3-94,       |
       |            BS8110-97, NSCP 2015                              |
       |                                            (c)SINCE 1989     |
       +==============================================================+
       |  MIDAS Information Technology Co.,Ltd.         (MIDAS IT)    |
       |  MIDAS IT Design Development Team                            |
       +==============================================================+
       |            HomePage : www.MidasUser.com                      |
       +==============================================================+
       |  Gen 2022                                                    |
       +==============================================================+


    *. DEFINITION OF LOAD COMBINATIONS WITH SCALING UP FACTORS.
---------------------------------------------------------------------------------------
     LCB  C    Loadcase Name(Factor) + Loadcase Name(Factor) + Loadcase Name(Factor)
---------------------------------------------------------------------------------------
       9  1               D( 1.400) +          D1( 1.400)
      10  1               D( 1.200) +          D1( 1.200) +            Lr( 1.600)
           +                WX( 0.500)
      11  1               D( 1.200) +          D1( 1.200) +            Lr( 1.600)
           +                WY( 0.500)
      12  1               D( 1.200) +          D1( 1.200) +            Lr( 1.600)
           +                WX(-0.500)
      13  1               D( 1.200) +          D1( 1.200) +            Lr( 1.600)
           +                WY(-0.500)
      14  1               D( 1.200) +          D1( 1.200) +            WX( 1.000)
           +                Lr( 0.500)
      15  1               D( 1.200) +          D1( 1.200) +            WY( 1.000)
           +                Lr( 0.500)
      16  1               D( 1.200) +          D1( 1.200) +            WX(-1.000)
           +                Lr( 0.500)
      17  1               D( 1.200) +          D1( 1.200) +            WY(-1.000)
           +                Lr( 0.500)
      18  1               D( 1.200) +          D1( 1.200) +         SRSS5( 1.000)
      19  1               D( 1.200) +          D1( 1.200) +         SRSS6( 1.000)
      20  1               D( 1.200) +          D1( 1.200) +         SRSS7( 1.000)
      21  1               D( 1.200) +          D1( 1.200) +         SRSS8( 1.000)
      22  1               D( 1.200) +          D1( 1.200) +         SRSS5(-1.000)
      23  1               D( 1.200) +          D1( 1.200) +         SRSS6(-1.000)
      24  1               D( 1.200) +          D1( 1.200) +         SRSS7(-1.000)
```

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 midas Gen - RC-Beam Design     [ NSR-10 ]                                    Gen 2022
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      25  1                D( 1.200) +           D1( 1.200) +          SRSS8(-1.000)
      26  1                D( 0.900) +           D1( 0.900) +             WX( 1.000)
      27  1                D( 0.900) +           D1( 0.900) +             WY( 1.000)
      28  1                D( 0.900) +           D1( 0.900) +             WX(-1.000)
      29  1                D( 0.900) +           D1( 0.900) +             WY(-1.000)
      30  1                D( 0.900) +           D1( 0.900) +          SRSS5( 1.000)
      31  1                D( 0.900) +           D1( 0.900) +          SRSS6( 1.000)
      32  1                D( 0.900) +           D1( 0.900) +          SRSS7( 1.000)
      33  1                D( 0.900) +           D1( 0.900) +          SRSS8( 1.000)
      34  1                D( 0.900) +           D1( 0.900) +          SRSS5(-1.000)
      35  1                D( 0.900) +           D1( 0.900) +          SRSS6(-1.000)
      36  1                D( 0.900) +           D1( 0.900) +          SRSS7(-1.000)
      37  1                D( 0.900) +           D1( 0.900) +          SRSS8(-1.000)
      38  2                D( 1.000) +           D1( 1.000)
      39  2                D( 1.000) +           D1( 1.000) +             Lr( 1.000)
      40  2                D( 1.000) +           D1( 1.000) +             WX( 1.000)
      41  2                D( 1.000) +           D1( 1.000) +             WY( 1.000)
      42  2                D( 1.000) +           D1( 1.000) +             WX(-1.000)
      43  2                D( 1.000) +           D1( 1.000) +             WY(-1.000)
      44  2                D( 1.000) +           D1( 1.000) +          SRSS5( 0.700)
      45  2                D( 1.000) +           D1( 1.000) +          SRSS6( 0.700)
      46  2                D( 1.000) +           D1( 1.000) +          SRSS7( 0.700)
      47  2                D( 1.000) +           D1( 1.000) +          SRSS8( 0.700)
      48  2                D( 1.000) +           D1( 1.000) +          SRSS5(-0.700)
      49  2                D( 1.000) +           D1( 1.000) +          SRSS6(-0.700)
      50  2                D( 1.000) +           D1( 1.000) +          SRSS7(-0.700)
      51  2                D( 1.000) +           D1( 1.000) +          SRSS8(-0.700)
      52  2                D( 1.000) +           D1( 1.000) +             WX( 0.750)
           +                 Lr( 0.750)
      53  2                D( 1.000) +           D1( 1.000) +             WY( 0.750)
           +                 Lr( 0.750)
      54  2                D( 1.000) +           D1( 1.000) +             WX(-0.750)
           +                 Lr( 0.750)
      55  2                D( 1.000) +           D1( 1.000) +             WY(-0.750)
           +                 Lr( 0.750)
      56  2                D( 1.000) +           D1( 1.000) +          SRSS5( 0.525)
      57  2                D( 1.000) +           D1( 1.000) +          SRSS6( 0.525)
      58  2                D( 1.000) +           D1( 1.000) +          SRSS7( 0.525)
      59  2                D( 1.000) +           D1( 1.000) +          SRSS8( 0.525)
      60  2                D( 1.000) +           D1( 1.000) +          SRSS5(-0.525)
      61  2                D( 1.000) +           D1( 1.000) +          SRSS6(-0.525)
      62  2                D( 1.000) +           D1( 1.000) +          SRSS7(-0.525)
      63  2                D( 1.000) +           D1( 1.000) +          SRSS8(-0.525)
      64  2                D( 0.600) +           D1( 0.600) +             WX( 1.000)
      65  2                D( 0.600) +           D1( 0.600) +             WY( 1.000)
      66  2                D( 0.600) +           D1( 0.600) +             WX(-1.000)
      67  2                D( 0.600) +           D1( 0.600) +             WY(-1.000)
      68  2                D( 0.600) +           D1( 0.600) +          SRSS5( 0.700)
      69  2                D( 0.600) +           D1( 0.600) +          SRSS6( 0.700)
      70  2                D( 0.600) +           D1( 0.600) +          SRSS7( 0.700)
      71  2                D( 0.600) +           D1( 0.600) +          SRSS8( 0.700)
      72  2                D( 0.600) +           D1( 0.600) +          SRSS5(-0.700)
```

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 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
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      73  2                D( 0.600) +            D1( 0.600) +          SRSS6(-0.700)
      74  2                D( 0.600) +            D1( 0.600) +          SRSS7(-0.700)
      75  2                D( 0.600) +            D1( 0.600) +          SRSS8(-0.700)
--------------------------------------------------------------------------------------
```

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------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                 Gen 2022
==========================================================================================

      *.midas Gen - RC-BEAM Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita - San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = BEAM,   MEMB =    13

      *.DESCRIPTION OF BEAM DATA (iSEC =     3) : VC30*45
        Section Type : Rectangle (RECT)
        Beam Length (Span)           =         7.000 m.
        Section Depth (Hc)           =         0.450 m.
        Section Width (Bc)           =         0.300 m.
        Concrete Strength (fc)       =     21000.000 KPa.
        Modulus of Elasticity (Ec)   =  21538105.766 KPa.
        Main Rebar Strength (fy)     =    420000.000 KPa.
        Stirrups Strength (fys)      =    420000.000 KPa.
        Modulus of Elasticity (Es)   = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).
        Members for Non-Seismic Design.

      *.FORCES AND MOMENTS AT CHECK POINT <I> :
        Positive Bending Moment   P-Mu =        9.74 kN-m.,  LCB =  21
        Negative Bending Moment   N-Mu =       55.84 kN-m.,  LCB =   9
        Shear Force                Vu  =       52.60 kN.  ,  LCB =   9

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------
           Location    i     di( m.)       Rebar    Asi( m^2.)
        ---------------------------------------------------------
           Top         1      0.075         2-#6      0.00057
           Bottom      2      0.375         2-#5      0.00040
        ---------------------------------------------------------
           Stirrups : #3

 ===============================================================================
    [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ===============================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy              =2.800e+05 KPa.
           -. cc   =    0.067 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.212 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.212 m.
           -. s    =    0.150 m. < smax  --->  O.K.
```

```
-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
=========================================================================================


      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0008
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0008
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0155
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0155

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0036
           -. Rhomin < Rho < Rhomax  --->  O.K !

      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.031 m.
           -. Mn     = As*fy*(d-a/2)      =       60.36 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       54.33 kN-m.

      ( ). Check ratio of positive moment capacity.
           -. Rat_P  = Mu/phiMn =    0.179  <  1.000  --->  O.K.

 ===============================================================================
    [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
 ===============================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.065 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.216 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.216 m.
           -. s    =    0.150 m. < smax  --->  O.K.

      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0049
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0155
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0155

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0050
           -. Rhomin < Rho < Rhomax  --->  O.K !
```

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---------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
=============================================================================================


      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.045 m.
           -. Mn     = As*fy*(d-a/2)      =       84.11 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       75.70 kN-m.

      ( ). Check ratio of negative moment capacity.
           -. Rat_N  = Mu/phiMn =    0.738  <  1.000  --->  O.K.

 ===============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY.
 ===============================================================================

      ( ). Compute shear strength of concrete.
           -. Vu     =        52.60 kN.
           -. Vc     = 0.17*SQRT(fc)*bw*d =       87.64 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc             =       65.73 kN.
           -. phiVc/2 < Vu < phiVc  --->  Minimum shear reinforcement is required.

      ( ). Compute required shear reinforcement. ( Av1 =  0.00007 m^2. )
           -. Avmin1 = 0.35*bw/fys           =2.500e-04 m^2/m.
           -. Avmin2 = 0.062*SQRT(fc)*bw/fys =2.029e-04 m^2/m.
           -. Av     = MAX[ Avmin1, Avmin2 ] =2.500e-04 m^2/m.
           -. N_leg  =  2
           -. Calculate spacing s1 = N_leg*Av1 / Av         =    0.568 m.
           -. Applied spacing s    = MIN[ s1, d/2, 600 mm ] =    0.188 m.
```

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----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
========================================================================================

      *.midas Gen - RC-BEAM Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita - San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = BEAM,   MEMB =    14

      *.DESCRIPTION OF BEAM DATA (iSEC =     3) : VC30*45
        Section Type : Rectangle (RECT)
        Beam Length (Span)            =         7.500 m.
        Section Depth (Hc)            =         0.450 m.
        Section Width (Bc)            =         0.300 m.
        Concrete Strength (fc)        =     21000.000 KPa.
        Modulus of Elasticity (Ec)    =  21538105.766 KPa.
        Main Rebar Strength (fy)      =    420000.000 KPa.
        Stirrups Strength (fys)       =    420000.000 KPa.
        Modulus of Elasticity (Es)    = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).
        Members for Non-Seismic Design.

      *.FORCES AND MOMENTS AT CHECK POINT <I> :
        Positive Bending Moment   P-Mu =       10.71 kN-m.,  LCB =  21
        Negative Bending Moment   N-Mu =       64.66 kN-m.,  LCB =   9
        Shear Force                Vu  =       56.47 kN.  ,  LCB =   9

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------
           Location    i     di( m.)       Rebar    Asi( m^2.)
        ---------------------------------------------------------
           Top         1      0.075         2-#6      0.00057
           Bottom      2      0.375         2-#5      0.00040
        ---------------------------------------------------------
           Stirrups : #3

 ================================================================================
    [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ================================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.067 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.212 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.212 m.
           -. s    =    0.150 m. < smax  --->  O.K.
```

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-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
=========================================================================================


      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0009
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0009
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0155
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0155

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0036
           -. Rhomin < Rho < Rhomax  --->  O.K !

      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.031 m.
           -. Mn     = As*fy*(d-a/2)      =       60.36 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       54.33 kN-m.

      ( ). Check ratio of positive moment capacity.
           -. Rat_P  = Mu/phiMn =    0.197  <  1.000  --->  O.K.

 =================================================================================
    [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
 =================================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500  ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.065 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.216 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.216 m.
           -. s    =    0.150 m. < smax  --->  O.K.

      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0057
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0155
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0155

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0050
           -. Rhomin < Rho < Rhomax  --->  O.K !
```

```
-------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
===========================================================================================


     ( ). Compute moment capacity.
          -. a      = As*fy/(0.85*fc*bw) =    0.045 m.
          -. Mn     = As*fy*(d-a/2)      =       84.11 kN-m.
          -. phi    = 0.90
          -. phiMn  = phi*Mn             =       75.70 kN-m.

     ( ). Check ratio of negative moment capacity.
          -. Rat_N  = Mu/phiMn =    0.854  <  1.000  --->  O.K.

 ================================================================================
   [[[*]]]   ANALYZE SHEAR CAPACITY.
 ================================================================================

     ( ). Compute shear strength of concrete.
          -. Vu     =       56.47 kN.
          -. Vc     = 0.17*SQRT(fc)*bw*d =       87.64 kN.
          -. phi    = 0.75
          -. phiVc  = phi*Vc             =       65.73 kN.
          -. phiVc/2 < Vu < phiVc  --->  Minimum shear reinforcement is required.

     ( ). Compute required shear reinforcement. ( Av1 =  0.00007 m^2. )
          -. Avmin1 = 0.35*bw/fys           =2.500e-04 m^2/m.
          -. Avmin2 = 0.062*SQRT(fc)*bw/fys =2.029e-04 m^2/m.
          -. Av     = MAX[ Avmin1, Avmin2 ] =2.500e-04 m^2/m.
          -. N_leg  =  2
          -. Calculate spacing s1 = N_leg*Av1 / Av         =    0.568 m.
          -. Applied spacing s    = MIN[ s1, d/2, 600 mm ] =    0.188 m.
```

```
-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
=========================================================================================

      *.midas Gen - RC-BEAM Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita - San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = BEAM,   MEMB =    15

      *.DESCRIPTION OF BEAM DATA (iSEC =     3) : VC30*45
        Section Type : Rectangle (RECT)
        Beam Length (Span)           =         7.000 m.
        Section Depth (Hc)           =         0.450 m.
        Section Width (Bc)           =         0.300 m.
        Concrete Strength (fc)       =     21000.000 KPa.
        Modulus of Elasticity (Ec)   =  21538105.766 KPa.
        Main Rebar Strength (fy)     =    420000.000 KPa.
        Stirrups Strength (fys)      =    420000.000 KPa.
        Modulus of Elasticity (Es)   = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).
        Members for Non-Seismic Design.

      *.FORCES AND MOMENTS AT CHECK POINT <I> :
        Positive Bending Moment   P-Mu =        9.74 kN-m.,  LCB =  21
        Negative Bending Moment   N-Mu =       55.84 kN-m.,  LCB =   9
        Shear Force                Vu  =       52.60 kN.  ,  LCB =   9

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------
           Location    i     di( m.)       Rebar    Asi( m^2.)
        ---------------------------------------------------------
           Top         1      0.075         2-#6      0.00057
           Bottom      2      0.375         2-#5      0.00040
        ---------------------------------------------------------
           Stirrups : #3

 ===============================================================================
    [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ===============================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.067 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.212 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.212 m.
           -. s    =    0.150 m. < smax  --->  O.K.
```

```
----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
========================================================================================


      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0008
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0008
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0155
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0155

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0036
           -. Rhomin < Rho < Rhomax  --->  O.K !

      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.031 m.
           -. Mn     = As*fy*(d-a/2)      =       60.36 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       54.33 kN-m.

      ( ). Check ratio of positive moment capacity.
           -. Rat_P  = Mu/phiMn =    0.179  <  1.000  --->  O.K.

 ==================================================================================
    [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
 ==================================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.065 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.216 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.216 m.
           -. s    =    0.150 m. < smax  --->  O.K.

      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0049
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0155
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0155

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0050
           -. Rhomin < Rho < Rhomax  --->  O.K !
```

```
--------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                 Gen 2022
======================================================================================


      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.045 m.
           -. Mn     = As*fy*(d-a/2)      =       84.11 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       75.70 kN-m.

      ( ). Check ratio of negative moment capacity.
           -. Rat_N  = Mu/phiMn =    0.738  <  1.000  --->  O.K.

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY.
 ============================================================================

      ( ). Compute shear strength of concrete.
           -. Vu     =       52.60 kN.
           -. Vc     = 0.17*SQRT(fc)*bw*d =       87.64 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc             =       65.73 kN.
           -. phiVc/2 < Vu < phiVc  --->  Minimum shear reinforcement is required.

      ( ). Compute required shear reinforcement. ( Av1 =  0.00007 m^2. )
           -. Avmin1 = 0.35*bw/fys           =2.500e-04 m^2/m.
           -. Avmin2 = 0.062*SQRT(fc)*bw/fys =2.029e-04 m^2/m.
           -. Av     = MAX[ Avmin1, Avmin2 ] =2.500e-04 m^2/m.
           -. N_leg  =  2
           -. Calculate spacing s1 = N_leg*Av1 / Av         =    0.568 m.
           -. Applied spacing s    = MIN[ s1, d/2, 600 mm ] =    0.188 m.
```

PROJECT TITLE : Acueducto Agua Bonita - San José del Guaviare

	Company	Leandro Castellanos	Client	
MIDAS	Author	Leandro Castellanos	File Name	Caseta.rcs

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------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
==========================================================================================

      *.midas Gen - RC-BEAM Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita - San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = BEAM,   MEMB =    16

      *.DESCRIPTION OF BEAM DATA (iSEC =     3) : VC30*45
        Section Type : Rectangle (RECT)
        Beam Length (Span)            =         7.500 m.
        Section Depth (Hc)            =         0.450 m.
        Section Width (Bc)            =         0.300 m.
        Concrete Strength (fc)        =     21000.000 KPa.
        Modulus of Elasticity (Ec)    =  21538105.766 KPa.
        Main Rebar Strength (fy)      =    420000.000 KPa.
        Stirrups Strength (fys)       =    420000.000 KPa.
        Modulus of Elasticity (Es)    = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).
        Members for Non-Seismic Design.

      *.FORCES AND MOMENTS AT CHECK POINT <I> :
        Positive Bending Moment   P-Mu =       10.71 kN-m.,  LCB =  21
        Negative Bending Moment   N-Mu =       64.66 kN-m.,  LCB =   9
        Shear Force                Vu  =       56.47 kN.  ,  LCB =   9

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------
           Location    i     di( m.)       Rebar    Asi( m^2.)
        ---------------------------------------------------------
           Top         1      0.075         2-#6      0.00057
           Bottom      2      0.375         2-#5      0.00040
        ---------------------------------------------------------
           Stirrups : #3

 ===============================================================================
    [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ===============================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500  ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.067 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.212 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.212 m.
           -. s    =    0.150 m. < smax  --->  O.K.
```

```
-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
=========================================================================================


      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0009
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0009
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0155
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0155

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0036
           -. Rhomin < Rho < Rhomax  --->  O.K !

      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.031 m.
           -. Mn     = As*fy*(d-a/2)      =       60.36 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       54.33 kN-m.

      ( ). Check ratio of positive moment capacity.
           -. Rat_P  = Mu/phiMn =    0.197  <  1.000  --->  O.K.

 ===============================================================================
    [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
 ===============================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.065 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.216 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.216 m.
           -. s    =    0.150 m. < smax  --->  O.K.

      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0057
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0155
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0155

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0050
           -. Rhomin < Rho < Rhomax  --->  O.K !
```

```
-------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
===========================================================================================


      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.045 m.
           -. Mn     = As*fy*(d-a/2)      =       84.11 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       75.70 kN-m.

      ( ). Check ratio of negative moment capacity.
           -. Rat_N  = Mu/phiMn =    0.854  <  1.000  --->  O.K.

 ===============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY.
 ===============================================================================

      ( ). Compute shear strength of concrete.
           -. Vu     =       56.47 kN.
           -. Vc     = 0.17*SQRT(fc)*bw*d =       87.64 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc             =       65.73 kN.
           -. phiVc/2 < Vu < phiVc  --->  Minimum shear reinforcement is required.

      ( ). Compute required shear reinforcement. ( Av1 =  0.00007 m^2. )
           -. Avmin1 = 0.35*bw/fys           =2.500e-04 m^2/m.
           -. Avmin2 = 0.062*SQRT(fc)*bw/fys =2.029e-04 m^2/m.
           -. Av     = MAX[ Avmin1, Avmin2 ] =2.500e-04 m^2/m.
           -. N_leg  =  2
           -. Calculate spacing s1 = N_leg*Av1 / Av         =    0.568 m.
           -. Applied spacing s    = MIN[ s1, d/2, 600 mm ] =    0.188 m.
```

PROJECT TITLE :	Acueducto Agua Bonita - San José del Guaviare		
Company	Leandro Castellanos	Client	
Author	Leandro Castellanos	File Name	Caseta.rcs

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-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
=========================================================================================


       +==============================================================+
       |  MIDAS(Modeling, Integrated Design & Analysis Software)      |
       |  midas Gen - Design & checking system for windows            |
       +==============================================================+
       |  RC-Member(Beam/Column/Brace/Wall) Analysis and Design       |
       |  Based On  Eurocode2:04, Eurocode2, ACI318-19,               |
       |            ACI318M-19, ACI318-14, ACI318M-14, ACI318-11,     |
       |            ACI318-08, ACI318-05, ACI318-02, ACI318-99,       |
       |            ACI318-95, ACI318-89, NSR-10, CSA-A23.3-94,       |
       |            BS8110-97, NSCP 2015                              |
       |                                             (c)SINCE 1989    |
       +==============================================================+
       |  MIDAS Information Technology Co.,Ltd.         (MIDAS IT)    |
       |  MIDAS IT Design Development Team                            |
       +==============================================================+
       |            HomePage : www.MidasUser.com                      |
       +==============================================================+
       |  Gen 2022                                                    |
       +==============================================================+


    *. DEFINITION OF LOAD COMBINATIONS WITH SCALING UP FACTORS.
-------------------------------------------------------------------------------------
     LCB  C    Loadcase Name(Factor) + Loadcase Name(Factor) + Loadcase Name(Factor)
-------------------------------------------------------------------------------------
       9  1                D( 1.400) +           D1( 1.400)
      10  1                D( 1.200) +           D1( 1.200) +           Lr( 1.600)
          +                  WX( 0.500)
      11  1                D( 1.200) +           D1( 1.200) +           Lr( 1.600)
          +                  WY( 0.500)
      12  1                D( 1.200) +           D1( 1.200) +           Lr( 1.600)
          +                  WX(-0.500)
      13  1                D( 1.200) +           D1( 1.200) +           Lr( 1.600)
          +                  WY(-0.500)
      14  1                D( 1.200) +           D1( 1.200) +           WX( 1.000)
          +                  Lr( 0.500)
      15  1                D( 1.200) +           D1( 1.200) +           WY( 1.000)
          +                  Lr( 0.500)
      16  1                D( 1.200) +           D1( 1.200) +           WX(-1.000)
          +                  Lr( 0.500)
      17  1                D( 1.200) +           D1( 1.200) +           WY(-1.000)
          +                  Lr( 0.500)
      18  1                D( 1.200) +           D1( 1.200) +        SRSS5( 1.000)
      19  1                D( 1.200) +           D1( 1.200) +        SRSS6( 1.000)
      20  1                D( 1.200) +           D1( 1.200) +        SRSS7( 1.000)
      21  1                D( 1.200) +           D1( 1.200) +        SRSS8( 1.000)
      22  1                D( 1.200) +           D1( 1.200) +        SRSS5(-1.000)
      23  1                D( 1.200) +           D1( 1.200) +        SRSS6(-1.000)
      24  1                D( 1.200) +           D1( 1.200) +        SRSS7(-1.000)
```

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-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                 Gen 2022
=========================================================================================

      25  1                D( 1.200) +           D1( 1.200) +          SRSS8(-1.000)
      26  1                D( 0.900) +           D1( 0.900) +             WX( 1.000)
      27  1                D( 0.900) +           D1( 0.900) +             WY( 1.000)
      28  1                D( 0.900) +           D1( 0.900) +             WX(-1.000)
      29  1                D( 0.900) +           D1( 0.900) +             WY(-1.000)
      30  1                D( 0.900) +           D1( 0.900) +          SRSS5( 1.000)
      31  1                D( 0.900) +           D1( 0.900) +          SRSS6( 1.000)
      32  1                D( 0.900) +           D1( 0.900) +          SRSS7( 1.000)
      33  1                D( 0.900) +           D1( 0.900) +          SRSS8( 1.000)
      34  1                D( 0.900) +           D1( 0.900) +          SRSS5(-1.000)
      35  1                D( 0.900) +           D1( 0.900) +          SRSS6(-1.000)
      36  1                D( 0.900) +           D1( 0.900) +          SRSS7(-1.000)
      37  1                D( 0.900) +           D1( 0.900) +          SRSS8(-1.000)
      38  2                D( 1.000) +           D1( 1.000)
      39  2                D( 1.000) +           D1( 1.000) +             Lr( 1.000)
      40  2                D( 1.000) +           D1( 1.000) +             WX( 1.000)
      41  2                D( 1.000) +           D1( 1.000) +             WY( 1.000)
      42  2                D( 1.000) +           D1( 1.000) +             WX(-1.000)
      43  2                D( 1.000) +           D1( 1.000) +             WY(-1.000)
      44  2                D( 1.000) +           D1( 1.000) +          SRSS5( 0.700)
      45  2                D( 1.000) +           D1( 1.000) +          SRSS6( 0.700)
      46  2                D( 1.000) +           D1( 1.000) +          SRSS7( 0.700)
      47  2                D( 1.000) +           D1( 1.000) +          SRSS8( 0.700)
      48  2                D( 1.000) +           D1( 1.000) +          SRSS5(-0.700)
      49  2                D( 1.000) +           D1( 1.000) +          SRSS6(-0.700)
      50  2                D( 1.000) +           D1( 1.000) +          SRSS7(-0.700)
      51  2                D( 1.000) +           D1( 1.000) +          SRSS8(-0.700)
      52  2                D( 1.000) +           D1( 1.000) +             WX( 0.750)
            +                Lr( 0.750)
      53  2                D( 1.000) +           D1( 1.000) +             WY( 0.750)
            +                Lr( 0.750)
      54  2                D( 1.000) +           D1( 1.000) +             WX(-0.750)
            +                Lr( 0.750)
      55  2                D( 1.000) +           D1( 1.000) +             WY(-0.750)
            +                Lr( 0.750)
      56  2                D( 1.000) +           D1( 1.000) +          SRSS5( 0.525)
      57  2                D( 1.000) +           D1( 1.000) +          SRSS6( 0.525)
      58  2                D( 1.000) +           D1( 1.000) +          SRSS7( 0.525)
      59  2                D( 1.000) +           D1( 1.000) +          SRSS8( 0.525)
      60  2                D( 1.000) +           D1( 1.000) +          SRSS5(-0.525)
      61  2                D( 1.000) +           D1( 1.000) +          SRSS6(-0.525)
      62  2                D( 1.000) +           D1( 1.000) +          SRSS7(-0.525)
      63  2                D( 1.000) +           D1( 1.000) +          SRSS8(-0.525)
      64  2                D( 0.600) +           D1( 0.600) +             WX( 1.000)
      65  2                D( 0.600) +           D1( 0.600) +             WY( 1.000)
      66  2                D( 0.600) +           D1( 0.600) +             WX(-1.000)
      67  2                D( 0.600) +           D1( 0.600) +             WY(-1.000)
      68  2                D( 0.600) +           D1( 0.600) +          SRSS5( 0.700)
      69  2                D( 0.600) +           D1( 0.600) +          SRSS6( 0.700)
      70  2                D( 0.600) +           D1( 0.600) +          SRSS7( 0.700)
      71  2                D( 0.600) +           D1( 0.600) +          SRSS8( 0.700)
      72  2                D( 0.600) +           D1( 0.600) +          SRSS5(-0.700)
```

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------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                     Gen 2022
==========================================================================================

      73  2                D( 0.600) +            D1( 0.600) +          SRSS6(-0.700)
      74  2                D( 0.600) +            D1( 0.600) +          SRSS7(-0.700)
      75  2                D( 0.600) +            D1( 0.600) +          SRSS8(-0.700)
--------------------------------------------------------------------------------------
```

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 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
===========================================================================================

      *.midas Gen - RC-BEAM Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita - San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = BEAM,   MEMB =     9

      *.DESCRIPTION OF BEAM DATA (iSEC =     2) : V20*40
        Section Type : Rectangle (RECT)
        Beam Length (Span)          =         7.500 m.
        Section Depth (Hc)          =         0.400 m.
        Section Width (Bc)          =         0.200 m.
        Concrete Strength (fc)      =     21000.000 KPa.
        Modulus of Elasticity (Ec)  =  21538105.766 KPa.
        Main Rebar Strength (fy)    =    420000.000 KPa.
        Stirrups Strength (fys)     =    420000.000 KPa.
        Modulus of Elasticity (Es)  = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

      *.FORCES AND MOMENTS AT CHECK POINT <I> :
        Positive Bending Moment   P-Mu =       13.18 kN-m.,  LCB =  10
        Negative Bending Moment   N-Mu =       34.91 kN-m.,  LCB =  12
        Shear Force                Vu  =       30.35 kN.  ,  LCB =  12

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------
           Location    i     di( m.)       Rebar    Asi( m^2.)
        ---------------------------------------------------------
           Top         1      0.053      2- 1-#4      0.00039
           Bottom      2      0.360         2-#4      0.00026
        ---------------------------------------------------------
           Stirrups : #3

 ===============================================================================
    [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ===============================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs    = (2/3)*fy             =2.800e+05 KPa.
           -. cc    =    0.034 m.
           -. s1    = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2    = 300*(280/fs)         =    0.300 m.
           -. smax  = MIN[ s1, s2 ]        =    0.296 m.
           -. s     =    0.120 m. < smax  --->  O.K.
```

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 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
============================================================================================


      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]            =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]            =   0.0018
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                      =   0.0018
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0155
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                     =   0.0155

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0036
           -. Rhomin < Rho < Rhomax  --->  O.K !

      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.030 m.
           -. Mn     = As*fy*(d-a/2)      =       37.37 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       33.64 kN-m.

      ( ). Check ratio of positive moment capacity.
           -. Rat_P  = Mu/phiMn =    0.392  <  1.000  --->  O.K.

 ===================================================================================
    [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
 ===================================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.120 m. < smax  --->  O.K.

      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]            =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]            =   0.0054
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                      =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0155
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                     =   0.0155

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0056
           -. Rhomin < Rho < Rhomax  --->  O.K !
```

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---------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
=============================================================================================


      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.046 m.
           -. Mn     = As*fy*(d-a/2)      =       52.78 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       47.51 kN-m.

      ( ). Check ratio of negative moment capacity.
           -. Rat_N  = Mu/phiMn =    0.735  <  1.000  --->  O.K.

 ===============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY.
 ===============================================================================

      ( ). Compute shear strength of concrete.
           -. Vu     =       30.35 kN.
           -. Vc     = 0.17*SQRT(fc)*bw*d =       54.13 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc             =       40.60 kN.
           -. phiVc/2 < Vu < phiVc  --->  Minimum shear reinforcement is required.

      ( ). Compute required shear reinforcement. ( Av1 =  0.00007 m^2. )
           -. Avmin1 = 0.35*bw/fys          =1.667e-04 m^2/m.
           -. Avmin2 = 0.062*SQRT(fc)*bw/fys =1.353e-04 m^2/m.
           -. Av     = MAX[ Avmin1, Avmin2 ] =1.667e-04 m^2/m.
           -. N_leg  =  2
           -. Calculate spacing s1 = N_leg*Av1 / Av         =    0.852 m.
           -. Applied spacing s    = MIN[ s1, d/2, 600 mm ] =    0.174 m.
```

	Company	Leandro Castellanos	Client	
MIDAS	Author	Leandro Castellanos	File Name	Caseta.rcs

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 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
=========================================================================================

      *.midas Gen - RC-BEAM Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita - San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = BEAM,   MEMB =    10

      *.DESCRIPTION OF BEAM DATA (iSEC =     2) : V20*40
        Section Type : Rectangle (RECT)
        Beam Length (Span)          =         7.000 m.
        Section Depth (Hc)          =         0.400 m.
        Section Width (Bc)          =         0.200 m.
        Concrete Strength (fc)      =     21000.000 KPa.
        Modulus of Elasticity (Ec)  =  21538105.766 KPa.
        Main Rebar Strength (fy)    =    420000.000 KPa.
        Stirrups Strength (fys)     =    420000.000 KPa.
        Modulus of Elasticity (Es)  = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

      *.FORCES AND MOMENTS AT CHECK POINT <I> :
        Positive Bending Moment   P-Mu =       11.53 kN-m.,  LCB =  21
        Negative Bending Moment   N-Mu =       28.68 kN-m.,  LCB =  11
        Shear Force                Vu  =       27.09 kN.  ,  LCB =  11

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------
           Location    i     di( m.)       Rebar    Asi( m^2.)
        ---------------------------------------------------------
           Top         1      0.040         2-#4      0.00026
           Bottom      2      0.360         2-#4      0.00026
        ---------------------------------------------------------
           Stirrups : #3

 ===============================================================================
    [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ===============================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.120 m. < smax  --->  O.K.
```

```
-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
=========================================================================================


      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0016
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0016
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0155
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0155

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0036
           -. Rhomin < Rho < Rhomax  --->  O.K !

      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.030 m.
           -. Mn     = As*fy*(d-a/2)      =       37.37 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       33.64 kN-m.

      ( ). Check ratio of positive moment capacity.
           -. Rat_P  = Mu/phiMn =    0.343  <  1.000  --->  O.K.

 ===================================================================================
    [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
 ===================================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500  ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy              =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.120 m. < smax  --->  O.K.

      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0040
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0155
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0155

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0036
           -. Rhomin < Rho < Rhomax  --->  O.K !
```

```
---------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
=============================================================================================


      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.030 m.
           -. Mn     = As*fy*(d-a/2)      =       37.37 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       33.64 kN-m.

      ( ). Check ratio of negative moment capacity.
           -. Rat_N  = Mu/phiMn =    0.853  <  1.000  --->  O.K.

 ===============================================================================
   [[[*]]]   ANALYZE SHEAR CAPACITY.
 ===============================================================================

      ( ). Compute shear strength of concrete.
           -. Vu     =       27.09 kN.
           -. Vc     = 0.17*SQRT(fc)*bw*d =       56.09 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc             =       42.07 kN.
           -. phiVc/2 < Vu < phiVc  --->  Minimum shear reinforcement is required.

      ( ). Compute required shear reinforcement. ( Av1 =  0.00007 m^2. )
           -. Avmin1 = 0.35*bw/fys           =1.667e-04 m^2/m.
           -. Avmin2 = 0.062*SQRT(fc)*bw/fys =1.353e-04 m^2/m.
           -. Av     = MAX[ Avmin1, Avmin2 ] =1.667e-04 m^2/m.
           -. N_leg  =  2
           -. Calculate spacing s1 = N_leg*Av1 / Av         =    0.852 m.
           -. Applied spacing s    = MIN[ s1, d/2, 600 mm ] =    0.180 m.
```

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-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                 Gen 2022
=========================================================================================

      *.midas Gen - RC-BEAM Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita - San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = BEAM,   MEMB =    11

      *.DESCRIPTION OF BEAM DATA (iSEC =     2) : V20*40
        Section Type : Rectangle (RECT)
        Beam Length (Span)            =         7.500 m.
        Section Depth (Hc)            =         0.400 m.
        Section Width (Bc)            =         0.200 m.
        Concrete Strength (fc)        =     21000.000 KPa.
        Modulus of Elasticity (Ec)    =  21538105.766 KPa.
        Main Rebar Strength (fy)      =    420000.000 KPa.
        Stirrups Strength (fys)       =    420000.000 KPa.
        Modulus of Elasticity (Es)    = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

      *.FORCES AND MOMENTS AT CHECK POINT <I> :
        Positive Bending Moment   P-Mu =       13.18 kN-m.,  LCB =  12
        Negative Bending Moment   N-Mu =       34.91 kN-m.,  LCB =  10
        Shear Force                Vu  =       30.35 kN.  ,  LCB =  10

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------
           Location    i     di( m.)       Rebar    Asi( m^2.)
        ---------------------------------------------------------
           Top         1      0.053      2- 1-#4      0.00039
           Bottom      2      0.360         2-#4      0.00026
        ---------------------------------------------------------
           Stirrups : #3

 ===============================================================================
    [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ===============================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.120 m. < smax  --->  O.K.
```

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----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                 Gen 2022
========================================================================================


      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0018
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0018
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0155
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0155

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0036
           -. Rhomin < Rho < Rhomax  --->  O.K !

      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.030 m.
           -. Mn     = As*fy*(d-a/2)      =       37.37 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       33.64 kN-m.

      ( ). Check ratio of positive moment capacity.
           -. Rat_P  = Mu/phiMn =    0.392  <  1.000  --->  O.K.

 ==================================================================================
    [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
 ==================================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.120 m. < smax  --->  O.K.

      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0054
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0155
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0155

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0056
           -. Rhomin < Rho < Rhomax  --->  O.K !
```

```
-------------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                    Gen 2022
===========================================================================================


      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.046 m.
           -. Mn     = As*fy*(d-a/2)      =       52.78 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       47.51 kN-m.

      ( ). Check ratio of negative moment capacity.
           -. Rat_N  = Mu/phiMn =    0.735  <  1.000  --->  O.K.

 ===============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY.
 ===============================================================================

      ( ). Compute shear strength of concrete.
           -. Vu     =        30.35 kN.
           -. Vc     = 0.17*SQRT(fc)*bw*d =       54.13 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc             =       40.60 kN.
           -. phiVc/2 < Vu < phiVc  --->  Minimum shear reinforcement is required.

      ( ). Compute required shear reinforcement. ( Av1 =  0.00007 m^2. )
           -. Avmin1 = 0.35*bw/fys           =1.667e-04 m^2/m.
           -. Avmin2 = 0.062*SQRT(fc)*bw/fys =1.353e-04 m^2/m.
           -. Av     = MAX[ Avmin1, Avmin2 ] =1.667e-04 m^2/m.
           -. N_leg  =  2
           -. Calculate spacing s1 = N_leg*Av1 / Av         =    0.852 m.
           -. Applied spacing s    = MIN[ s1, d/2, 600 mm ] =    0.174 m.
```

```
-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
=========================================================================================

      *.midas Gen - RC-BEAM Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita - San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = BEAM,   MEMB =    12

      *.DESCRIPTION OF BEAM DATA (iSEC =     2) : V20*40
        Section Type : Rectangle (RECT)
        Beam Length (Span)          =         7.000 m.
        Section Depth (Hc)          =         0.400 m.
        Section Width (Bc)          =         0.200 m.
        Concrete Strength (fc)      =     21000.000 KPa.
        Modulus of Elasticity (Ec)  =  21538105.766 KPa.
        Main Rebar Strength (fy)    =    420000.000 KPa.
        Stirrups Strength (fys)     =    420000.000 KPa.
        Modulus of Elasticity (Es)  = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

      *.FORCES AND MOMENTS AT CHECK POINT <I> :
        Positive Bending Moment   P-Mu =       11.53 kN-m.,  LCB =  21
        Negative Bending Moment   N-Mu =       28.68 kN-m.,  LCB =  13
        Shear Force                Vu  =       27.09 kN.  ,  LCB =  13

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------
           Location    i     di( m.)       Rebar    Asi( m^2.)
        ---------------------------------------------------------
           Top         1      0.040         2-#4      0.00026
           Bottom      2      0.360         2-#4      0.00026
        ---------------------------------------------------------
           Stirrups : #3

 ================================================================================
    [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ================================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.120 m. < smax  --->  O.K.
```

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-----------------------------------------------------------------------------------------
 midas Gen - RC-Beam Design     [ NSR-10 ]                                  Gen 2022
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      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0016
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0016
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0155
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0155

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0036
           -. Rhomin < Rho < Rhomax  --->  O.K !

      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.030 m.
           -. Mn     = As*fy*(d-a/2)      =       37.37 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       33.64 kN-m.

      ( ). Check ratio of positive moment capacity.
           -. Rat_P  = Mu/phiMn =    0.343  <  1.000  --->  O.K.

 ===================================================================================
    [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
 ===================================================================================

      ( ). Compute design parameter.
           -. beta1  = 0.8500   ( fc < 28 MPa.)

      ( ). Check spacing of reinforcement closet to the tensile face.
           -. fs   = (2/3)*fy             =2.800e+05 KPa.
           -. cc   =    0.034 m.
           -. s1   = 380*(280/fs) - 2.5Cc =    0.296 m.
           -. s2   = 300*(280/fs)         =    0.300 m.
           -. smax = MIN[ s1, s2 ]        =    0.296 m.
           -. s    =    0.120 m. < smax  --->  O.K.

      ( ). Compute required ratio of reinforcement.
           -. k      = 1.000000
           -. Rhomi1 = MAX[ 0.25*SQRT(fc)/fy, 1.4/fy ]           =   0.0033
           -. Rhomi2 = (4/3)*Mu/[ phi*fy*b*d*(d-a/2) ]           =   0.0040
           -. Rhomin = MIN[ Rhomi1, Rhomi2 ]                     =   0.0033
           -. Rho_et = 0.85*beta1*(fc/fy)*(0.003/(0.003+0.004)) =   0.0155
           -. Rhomax = MIN[ k*Rho_et, 0.025 ]                    =   0.0155

      ( ). Check ratio of tensile reinforcement.
           -. Rho = As/(bw*d) =   0.0036
           -. Rhomin < Rho < Rhomax  --->  O.K !
```

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 midas Gen - RC-Beam Design     [ NSR-10 ]                               Gen 2022
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      ( ). Compute moment capacity.
           -. a      = As*fy/(0.85*fc*bw) =    0.030 m.
           -. Mn     = As*fy*(d-a/2)      =       37.37 kN-m.
           -. phi    = 0.90
           -. phiMn  = phi*Mn             =       33.64 kN-m.

      ( ). Check ratio of negative moment capacity.
           -. Rat_N  = Mu/phiMn =    0.853  <  1.000  --->  O.K.

 ===============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY.
 ===============================================================================

      ( ). Compute shear strength of concrete.
           -. Vu     =       27.09 kN.
           -. Vc     = 0.17*SQRT(fc)*bw*d =       56.09 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc             =       42.07 kN.
           -. phiVc/2 < Vu < phiVc  --->  Minimum shear reinforcement is required.

      ( ). Compute required shear reinforcement. ( Av1 =  0.00007 m^2. )
           -. Avmin1 = 0.35*bw/fys           =1.667e-04 m^2/m.
           -. Avmin2 = 0.062*SQRT(fc)*bw/fys =1.353e-04 m^2/m.
           -. Av     = MAX[ Avmin1, Avmin2 ] =1.667e-04 m^2/m.
           -. N_leg  =  2
           -. Calculate spacing s1 = N_leg*Av1 / Av         =    0.852 m.
           -. Applied spacing s    = MIN[ s1, d/2, 600 mm ] =    0.180 m.
```

PROJECT TITLE : Acueducto Agua Bonita - San José del Guaviare

	Company	Leandro Castellanos	Client	
MIDAS	Author	Leandro Castellanos	File Name	Caseta.rcs

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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       +==============================================================+
       |  MIDAS(Modeling, Integrated Design & Analysis Software)      |
       |  midas Gen - Design & checking system for windows            |
       +==============================================================+
       |  RC-Member(Beam/Column/Brace/Wall) Analysis and Design       |
       |  Based On  Eurocode2:04, Eurocode2, ACI318-19,               |
       |            ACI318M-19, ACI318-14, ACI318M-14, ACI318-11,     |
       |            ACI318-08, ACI318-05, ACI318-02, ACI318-99,       |
       |            ACI318-95, ACI318-89, NSR-10, CSA-A23.3-94,       |
       |            BS8110-97, NSCP 2015                              |
       |                                              (c)SINCE 1989  |
       +==============================================================+
       |  MIDAS Information Technology Co.,Ltd.         (MIDAS IT)   |
       |  MIDAS IT Design Development Team                            |
       +==============================================================+
       |            HomePage : www.MidasUser.com                      |
       +==============================================================+
       |  Gen 2022                                                    |
       +==============================================================+


    *. DEFINITION OF LOAD COMBINATIONS WITH SCALING UP FACTORS.
-------------------------------------------------------------------------------------
     LCB  C    Loadcase Name(Factor) + Loadcase Name(Factor) + Loadcase Name(Factor)
-------------------------------------------------------------------------------------
       9  1              D( 1.400) +            D1( 1.400)
      10  1              D( 1.200) +            D1( 1.200) +            Lr( 1.600)
           +               WX( 0.500)
      11  1              D( 1.200) +            D1( 1.200) +            Lr( 1.600)
           +               WY( 0.500)
      12  1              D( 1.200) +            D1( 1.200) +            Lr( 1.600)
           +               WX(-0.500)
      13  1              D( 1.200) +            D1( 1.200) +            Lr( 1.600)
           +               WY(-0.500)
      14  1              D( 1.200) +            D1( 1.200) +            WX( 1.000)
           +               Lr( 0.500)
      15  1              D( 1.200) +            D1( 1.200) +            WY( 1.000)
           +               Lr( 0.500)
      16  1              D( 1.200) +            D1( 1.200) +            WX(-1.000)
           +               Lr( 0.500)
      17  1              D( 1.200) +            D1( 1.200) +            WY(-1.000)
           +               Lr( 0.500)
      18  1              D( 1.200) +            D1( 1.200) +         SRSS5( 1.000)
      19  1              D( 1.200) +            D1( 1.200) +         SRSS6( 1.000)
      20  1              D( 1.200) +            D1( 1.200) +         SRSS7( 1.000)
      21  1              D( 1.200) +            D1( 1.200) +         SRSS8( 1.000)
      22  1              D( 1.200) +            D1( 1.200) +         SRSS5(-1.000)
      23  1              D( 1.200) +            D1( 1.200) +         SRSS6(-1.000)
      24  1              D( 1.200) +            D1( 1.200) +         SRSS7(-1.000)
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                     Gen 2022
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      25  1                 D( 1.200) +            D1( 1.200) +          SRSS8(-1.000)
      26  1                 D( 0.900) +            D1( 0.900) +             WX( 1.000)
      27  1                 D( 0.900) +            D1( 0.900) +             WY( 1.000)
      28  1                 D( 0.900) +            D1( 0.900) +             WX(-1.000)
      29  1                 D( 0.900) +            D1( 0.900) +             WY(-1.000)
      30  1                 D( 0.900) +            D1( 0.900) +          SRSS5( 1.000)
      31  1                 D( 0.900) +            D1( 0.900) +          SRSS6( 1.000)
      32  1                 D( 0.900) +            D1( 0.900) +          SRSS7( 1.000)
      33  1                 D( 0.900) +            D1( 0.900) +          SRSS8( 1.000)
      34  1                 D( 0.900) +            D1( 0.900) +          SRSS5(-1.000)
      35  1                 D( 0.900) +            D1( 0.900) +          SRSS6(-1.000)
      36  1                 D( 0.900) +            D1( 0.900) +          SRSS7(-1.000)
      37  1                 D( 0.900) +            D1( 0.900) +          SRSS8(-1.000)
      38  2                 D( 1.000) +            D1( 1.000)
      39  2                 D( 1.000) +            D1( 1.000) +             Lr( 1.000)
      40  2                 D( 1.000) +            D1( 1.000) +             WX( 1.000)
      41  2                 D( 1.000) +            D1( 1.000) +             WY( 1.000)
      42  2                 D( 1.000) +            D1( 1.000) +             WX(-1.000)
      43  2                 D( 1.000) +            D1( 1.000) +             WY(-1.000)
      44  2                 D( 1.000) +            D1( 1.000) +          SRSS5( 0.700)
      45  2                 D( 1.000) +            D1( 1.000) +          SRSS6( 0.700)
      46  2                 D( 1.000) +            D1( 1.000) +          SRSS7( 0.700)
      47  2                 D( 1.000) +            D1( 1.000) +          SRSS8( 0.700)
      48  2                 D( 1.000) +            D1( 1.000) +          SRSS5(-0.700)
      49  2                 D( 1.000) +            D1( 1.000) +          SRSS6(-0.700)
      50  2                 D( 1.000) +            D1( 1.000) +          SRSS7(-0.700)
      51  2                 D( 1.000) +            D1( 1.000) +          SRSS8(-0.700)
      52  2                 D( 1.000) +            D1( 1.000) +             WX( 0.750)
               +              Lr( 0.750)
      53  2                 D( 1.000) +            D1( 1.000) +             WY( 0.750)
               +              Lr( 0.750)
      54  2                 D( 1.000) +            D1( 1.000) +             WX(-0.750)
               +              Lr( 0.750)
      55  2                 D( 1.000) +            D1( 1.000) +             WY(-0.750)
               +              Lr( 0.750)
      56  2                 D( 1.000) +            D1( 1.000) +          SRSS5( 0.525)
      57  2                 D( 1.000) +            D1( 1.000) +          SRSS6( 0.525)
      58  2                 D( 1.000) +            D1( 1.000) +          SRSS7( 0.525)
      59  2                 D( 1.000) +            D1( 1.000) +          SRSS8( 0.525)
      60  2                 D( 1.000) +            D1( 1.000) +          SRSS5(-0.525)
      61  2                 D( 1.000) +            D1( 1.000) +          SRSS6(-0.525)
      62  2                 D( 1.000) +            D1( 1.000) +          SRSS7(-0.525)
      63  2                 D( 1.000) +            D1( 1.000) +          SRSS8(-0.525)
      64  2                 D( 0.600) +            D1( 0.600) +             WX( 1.000)
      65  2                 D( 0.600) +            D1( 0.600) +             WY( 1.000)
      66  2                 D( 0.600) +            D1( 0.600) +             WX(-1.000)
      67  2                 D( 0.600) +            D1( 0.600) +             WY(-1.000)
      68  2                 D( 0.600) +            D1( 0.600) +          SRSS5( 0.700)
      69  2                 D( 0.600) +            D1( 0.600) +          SRSS6( 0.700)
      70  2                 D( 0.600) +            D1( 0.600) +          SRSS7( 0.700)
      71  2                 D( 0.600) +            D1( 0.600) +          SRSS8( 0.700)
      72  2                 D( 0.600) +            D1( 0.600) +          SRSS5(-0.700)
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                   Gen 2022
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      73  2                D( 0.600) +           D1( 0.600) +         SRSS6(-0.700)
      74  2                D( 0.600) +           D1( 0.600) +         SRSS7(-0.700)
      75  2                D( 0.600) +           D1( 0.600) +         SRSS8(-0.700)
-------------------------------------------------------------------------------------
```

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--------------------------------------------------------------------------------
 midas Gen - RC-Column Design   [ NSR-10 ]                               Gen 2022
================================================================================

      *.midas Gen - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita - San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = COLUMN ,  MEMB =     1,  LCB =   13,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     1) : C30*30
        Section Type : Rectangular with Ties (RT)
        Section Height (HTc)          =        3.300 m.
        Section Depth  (Hc)           =        0.300 m.
        Section Width  (Bc)           =        0.300 m.
        Concrete Cover to C.O.R. (do) =        0.040 m.
        Concrete Strength (fc)        =    21000.000 KPa.
        Modulus of Elasticity (Ec)    =  21538105.766 KPa.
        Main Rebar Strength (fy)      =   420000.000 KPa.
        Ties/Spirals Strength (fys)   =   420000.000 KPa.
        Modulus of Elasticity (Es)    = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

     *.REBAR PATTERN = RT -  8 -  3 - #4         Unit :  m.
        --------------------------------------------------------
           i         dyi         dzi      Rebar          Asi
        --------------------------------------------------------
           1      -0.110      -0.110      1-#4       0.00013
           2      -0.110       0.000      1-#4       0.00013
           3      -0.110       0.110      1-#4       0.00013
           4       0.000       0.110      1-#4       0.00013
           5       0.110       0.110      1-#4       0.00013
           6       0.110       0.000      1-#4       0.00013
           7       0.110      -0.110      1-#4       0.00013
           8       0.000      -0.110      1-#4       0.00013
        --------------------------------------------------------

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

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =   13
           ----------------------------------------------------------------------------
            Load Case              Pu          Myi          Myj          Mzi          Mzj
           ----------------------------------------------------------------------------
            DL                  46.41       -16.52        25.29        13.75       -20.88
            LL                  10.50        -3.25         6.08         2.64        -4.92
            DL+LL               56.91       -19.78        31.38        16.38       -25.79
            Others               0.32         0.00         0.00         1.20        -0.85
           ----------------------------------------------------------------------------
            DL+LL+Others        57.23       -19.78        31.38        17.59       -26.64
           ----------------------------------------------------------------------------
```

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--------------------------------------------------------------------------------------------
 midas Gen - RC-Column Design   [ NSR-10 ]                                    Gen 2022
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      ( ). Compute member end moments(M1,M2).  Unit : kN-m.
           -. For Dead Load(DL).
              My1D =        16.52,   My2D =        25.29
              Mz1D =        13.75,   Mz2D =        20.88
           -. For Gravity Load(DL+LL).
              My1G =        19.78,   My2G =        31.38
              Mz1G =        16.38,   Mz2G =        25.79
           -. For Total Load(DL+LL+WL(EL)).
              My1  =        19.78,   My2  =        31.38
              Mz1  =        17.59,   Mz2  =        26.64

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. Slenderness ratio limits.
              SRy(Braced)   =  34 + 12*MIN(|My1/My2|,0.5) =   40.000  (Reverse curvature)
              SRz(Braced)   =  34 + 12*MIN(|Mz1/Mz2|,0.5) =   40.000  (Reverse curvature)
           -. Radii of gyration.
              ry     =  0.30*Hc  =    0.090 m.
              rz     =  0.30*Bc  =    0.090 m.
           -. Unbraced lengths.
              Ly     =    3.300 m.
              Lz     =    3.300 m.
           -. Effective length factors.
              Ky     =    1.000
              Kz     =    1.000
           -. SLENy  =  Ky*Ly/ry  =   36.667  <=  SRy  --->  NOT SLENDER.
           -. SLENz  =  Kz*Lz/rz  =   36.667  <=  SRz  --->  NOT SLENDER.

      ( ). Moment magnification factors for major axis(DBy,DSy).
           -. DBy    =     1.00 (Default value)
           -. DSy    =     1.00 (Default value)

      ( ). Moment magnification factors for minor axis(DBz,DSz).
           -. DBz    =     1.00 (Default value)
           -. DSz    =     1.00 (Default value)

      ( ). Compute minimum moments(Mmin).
           -. emin_y  =  15 mm. + 0.03*Hc   =       0.024 m.
           -. emin_z  =  15 mm. + 0.03*Bc   =       0.024 m.
           -. Mmin_y  =  Pu * emin_y        =        1.37 kN-m.
           -. Mmin_z  =  Pu * emin_z        =        1.37 kN-m.

      ( ). Compute magnified moments. (Pos : J, Local-y : Braced, Local-z : Braced).
           -. No sidesway moments.
              QMb_y  =  My_G   =       31.38 kN-m.
              QMb_z  =  Mz_G   =      -25.79 kN-m.
           -. Sidesway moments.
              QMs_y  =  My_S   =        0.00 kN-m.
              QMs_z  =  Mz_S   =       -0.85 kN-m.
           -. Compute magnified moments(Mcy,Mcz).
              Mcy(No-Slender) =  DBy*(QMb_y + QMs_y)              =       31.38 kN-m.
              Mcz(No-Slender) =  DBz*(QMb_z + QMs_z)              =      -26.64 kN-m.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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      ( ). Check total moment including 2nd-order effects.
           -. Moments due to 1st-order effects.
              Mcy-1st =        31.38 kN-m.
              Mcz-1st =        26.64 kN-m.
           -. Moments due to 2nd-order effects.
              Mcy-2nd = DBy*(QMb_y + QMs_y) =        31.38 kN-m.
              Mcz-2nd = DBz*(QMb_z + QMs_z) =        26.64 kN-m.
           -. Ratio of moment due to 2nd-order effects to moment due to 1st-order effects.
              Mcy-2nd / Mcy-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.
              Mcz-2nd / Mcz-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.

      ( ). Design forces/moments of column(brace).
           -. Axial Force (Compression)      Pu  =       57.23 kN.
           -. Combined Bending Moment        Mc  =       41.16 kN-m.
           -. Bending Moment about Local-y   Mcy =       31.38 kN-m.
           -. Bending Moment about Local-z   Mcz =      -26.64 kN-m.
           -. Shear Force of Local-y         Vuy =       15.58 kN.
           -. Shear Force of Local-z         Vuz =       18.29 kN.

 ===============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC_COLUMN(RC-BRACE).
 ===============================================================================

      ( ). Compute design parameters.
           -. Ag     =             0.0900 m^2.
           -. Ast    =             0.0010 m^2.
           -. Rhot   = Ast/Ag =   0.011470
           -. esu    = fy/Es  =   0.002100
           -. beta1  =   0.8500  ( fc < 28 MPa.)

      ( ). Check the ratio of reinforcement.
           -. Rhomin =   0.010000
           -. Rhomax =   0.040000
           -. Rhot   =   0.011470
              Rhomin < Rhot < Rhomax  --->  O.K !

      ( ). Compute eccentricities of biaxially loaded column.
           -. Ecny   = ABS(Mcz/Pu)     =      0.4655 m.
           -. Ecnz   = ABS(Mcy/Pu)     =      0.5482 m.
           -. Eccn   = ABS(Mc/Pu)      =      0.7192 m.
           -. Rota   = ATAN(Ecny/Ecnz) =     40.3337 deg.
           -. Rotation of neutral axis =     40.3337 deg.

      ( ). Compute concentric axial load capacity.
           -. Po     = (0.85*fc)*(Ag-Ast) + fy*Ast    =     2021.62 kN.
           -. Maximum Axial Load    : Pomax = 0.75*Po =     1516.22 kN.
           -. Maximum Axial Tension : Pt    = -fy*Ast =     -433.55 kN.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                      Gen 2022
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     ---------------------------------------------------------------------------
       *. Analysis of balanced condition.
     ---------------------------------------------------------------------------

      ( ). Compute capacity of concrete stress block.
           -. cb     = (0.003/(0.003+esu))*d  =       0.216 m.
           -. ab     = beta1*cb               =       0.183 m.
           -. Acom                            =       0.034 m^2.
           -. DCcy                            =       0.056 m.
           -. DCcz                            =       0.070 m.
           -. Cc     = 0.85*fc*Acom           =      607.38 kN.
           -. MnCy   = Cc*DCcz                =       42.44 kN-m.
           -. MnCz   = Cc*DCcy                =       33.79 kN-m.

      ( ). Compute capacity of reinforcement.
      ------------------------------------------------------------------------------------------------
       i      dsi       esi         fsi        Asi          Fsi      dzi       MnPyi      dyi      MnPzi
      ------------------------------------------------------------------------------------------------
       1    0.366 -0.002100 -420000.00  1.290e-04     -54.19   -0.110        5.96   -0.110       5.96
       2    0.283 -0.000933 -186619.14  1.290e-04     -24.08    0.000       -0.00   -0.110       2.65
       3    0.199  0.000234   46761.72  1.290e-04       6.03    0.110        0.66   -0.110      -0.66
       4    0.128  0.001225  244919.32  1.290e-04      31.60    0.110        3.48    0.000       0.00
       5    0.056  0.002215  420000.00  1.290e-04      54.19    0.110        5.96    0.110       5.96
       6    0.140  0.001048  209696.06  1.290e-04      27.06    0.000        0.00    0.110       2.98
       7    0.224 -0.000118  -23684.80  1.290e-04      -3.06   -0.110        0.34    0.110      -0.34
       8    0.295 -0.001109 -221842.40  1.290e-04     -28.62   -0.110        3.15    0.000      -0.00
      ------------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ----------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =        8.93 kN.
           -. MnPy   = SUM [ MnPyi ]  =       19.55 kN-m.
           -. MnPz   = SUM [ MnPzi ]  =       16.55 kN-m.

      ( ). Compute nominal capacity(Pb,Mb) of Balanced Condition.
           -. Pb     = Cc + Ps               =      616.31 kN.
           -. Mny    = MnCy + MnPy           =       61.99 kN-m.
           -. Mnz    = MnCz + MnPz           =       50.34 kN-m.
           -. Mb     = SQRT(Mny^2+Mnz^2)     =       79.85 kN-m.

      ( ). Compare actual eccentricity with balanced eccentricity.
           -. Balanced eccentricity : eb   = Mb/Pb        =    0.130 m.
           -. Minimum eccentricity  : Emin (not defined)  =    0.000 m.
           -. Actual eccentricity   : Eccn = Mu/Pu        =    0.719 m.
           -. eb   < Eccn       --->  Tension controls.

     ---------------------------------------------------------------------------
       *. Final analysis with searched neutral axis.
     ---------------------------------------------------------------------------
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
============================================================================================


      ( ). Search for neutral axis......     Unit :  kN.,  m.
           -. P-M calculation method : Keep P constant
          ------------------------------------------------------
           Trial          c       Phi*Pn       Pu       Ratio
          ------------------------------------------------------
            1-st      0.148       104.69      57.234     54.67
            2-nd      0.144        81.20      57.234     70.48
            3-rd      0.142        68.98      57.234     82.97
            4-th      0.140        62.73      57.234     91.23
            5-th      0.140        59.58      57.234     96.06
            6-th      0.140        57.99      57.234     98.69
            7-th      0.139        57.20      57.234     99.94
            8-th      0.140        57.59      57.234     99.37
            9-th      0.140        57.40      57.234     99.72
          ------------------------------------------------------

      ( ). Compute capacity of compression stress block.
           -. a      = beta1*c               =       0.119 m.
           -. Acom                           =       0.014 m^2.
           -. DCcy                           =       0.089 m.
           -. DCcz                           =       0.098 m.
           -. Cc     = 0.85*fc*Acom          =      254.47 kN.
           -. MnCy   = Cc*DCcz               =       24.97 kN-m.
           -. MnCz   = Cc*DCcy               =       22.63 kN-m.

      ( ). Compute capacity of reinforcement.
      ------------------------------------------------------------------------------------------------
       i      dsi       esi         fsi         Asi          Fsi      dzi       MnPyi      dyi       MnPzi
      ------------------------------------------------------------------------------------------------
       1    0.366 -0.004879 -420000.00  1.290e-04     -54.19   -0.110        5.96   -0.110        5.96
       2    0.283 -0.003076 -420000.00  1.290e-04     -54.19    0.000       -0.00   -0.110        5.96
       3    0.199 -0.001274 -254722.04  1.290e-04     -32.87    0.110       -3.62   -0.110        3.62
       4    0.128  0.000257   51420.31  1.290e-04       6.63    0.110        0.73    0.000        0.00
       5    0.056  0.001788  357562.67  1.290e-04      46.14    0.110        5.08    0.110        5.08
       6    0.140 -0.000015   -2997.64  1.290e-04      -0.39    0.000       -0.00    0.110       -0.04
       7    0.224 -0.001818 -363557.95  1.290e-04     -46.91   -0.110        5.16    0.110       -5.16
       8    0.295 -0.003349 -420000.00  1.290e-04     -54.19   -0.110        5.96    0.000       -0.00
      ------------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ----------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =     -189.97 kN.
           -. MnPy   = SUM [ MnPyi ]  =       19.27 kN-m.
           -. MnPz   = SUM [ MnPzi ]  =       15.41 kN-m.

      ( ). Compute nominal capacity(Pn,Mn) of given neutral axis.
           -. Pn     = Cc + Ps               =       64.49 kN.
           -. Mny    = MnCy + MnPy           =       44.24 kN-m.
           -. Mnz    = MnCz + MnPz           =       38.04 kN-m.
           -. Mn     = SQRT(Mny^2+Mnz^2)     =       58.35 kN-m.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute strength reduction factor.
           -. et      = 0.00488
           -. et_min  = 0.00210
           -. et_max  = 0.00500
           -. et_min < et < et_max  --->  phi = 0.65 + (et-0.002)*(250/3) =0.890  (Ties).

      ( ). Compute axial load and moment capacities(phiPn,phiMn).
           -. phiPn  = phi*Pn  =       57.40 kN.
           -. phiMn  = phi*Mn  =       51.93 kN-m.
           -. phiMny = phi*Mny =       39.37 kN-m.
           -. phiMnz = phi*Mnz =       33.85 kN-m.

      ( ). Check ratios of axial load and moment capacity.
           -. Rat_P  = Pu/phiPn = 0.997  <  1.000  --->  O.K.
           -. Rat_M  = Mc/phiMn = 0.793  <  1.000  --->  O.K.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.203 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   12,  POS = J )
           -. Applied axial force : Pu  =       57.19 kN.
           -. Applied shear force : Vuz =       18.29 kN.
           -. d      = Hc-do    =    0.260 m.
           -. Bw     = Bc       =    0.300 m.
           -. Acv    = Bw*d     =    0.078 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =       63.52 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =       47.64 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   18,  POS = J )
           -. Applied axial force : Pu  =       44.21 kN.
           -. Applied shear force : Vuy =       15.58 kN.
           -. d      = Bc-do    =    0.260 m.
           -. Bw     = Hc       =    0.300 m.
           -. Acv    = Bw*d     =    0.078 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =       62.90 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =       47.17 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.
```

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--------------------------------------------------------------------------------------------
 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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 ================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN ( MIDDLE ).
 ================================================================================

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.203 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   12,  POS = 1/2 )
           -. Applied axial force : Pu  =       61.46 kN.
           -. Applied shear force : Vuz =       18.29 kN.
           -. d      = Hc-do    =    0.260 m.
           -. Bw     = Bc       =    0.300 m.
           -. Acv    = Bw*d     =    0.078 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =       63.73 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =       47.80 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   18,  POS = 1/2 )
           -. Applied axial force : Pu  =       48.49 kN.
           -. Applied shear force : Vuy =       15.58 kN.
           -. d      = Bc-do    =    0.260 m.
           -. Bw     = Hc       =    0.300 m.
           -. Acv    = Bw*d     =    0.078 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =       63.10 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =       47.33 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.
      *.midas Gen - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita - San José del Guaviare
      *.DESIGN CODE   : NSR-10,          *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = COLUMN ,  MEMB =     2,  LCB =   13,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     1) : C30*30
        Section Type : Rectangular with Ties (RT)
        Section Height (HTc)            =        3.300 m.
        Section Depth  (Hc)             =        0.300 m.
        Section Width  (Bc)             =        0.300 m.
        Concrete Cover to C.O.R. (do)   =        0.040 m.
        Concrete Strength (fc)          =    21000.000 KPa.
        Modulus of Elasticity (Ec)      =  21538105.766 KPa.
        Main Rebar Strength (fy)        =    420000.000 KPa.
        Ties/Spirals Strength (fys)     =    420000.000 KPa.
        Modulus of Elasticity (Es)      = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

     *.REBAR PATTERN = RT -  8 -  3 - #4          Unit :  m.
        --------------------------------------------------------
           i          dyi           dzi      Rebar          Asi
        --------------------------------------------------------
           1       -0.110       -0.110      1-#4       0.00013
           2       -0.110        0.000      1-#4       0.00013
           3       -0.110        0.110      1-#4       0.00013
           4        0.000        0.110      1-#4       0.00013
           5        0.110        0.110      1-#4       0.00013
           6        0.110        0.000      1-#4       0.00013
           7        0.110       -0.110      1-#4       0.00013
           8        0.000       -0.110      1-#4       0.00013
        --------------------------------------------------------

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

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =    13
           ------------------------------------------------------------------------------
            Load Case             Pu          Myi           Myj           Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 46.41        16.52        -25.29         13.75       -20.88
            LL                 10.50         3.25         -6.08          2.64        -4.92
            DL+LL              56.91        19.78        -31.38         16.38       -25.79
            Others              0.32         0.00          0.00          1.20        -0.85
           ------------------------------------------------------------------------------
            DL+LL+Others       57.23        19.78        -31.38         17.59       -26.64
           ------------------------------------------------------------------------------

      ( ). Compute member end moments(M1,M2).  Unit : kN-m.
           -. For Dead Load(DL).
              My1D =        16.52,   My2D =        25.29
              Mz1D =        13.75,   Mz2D =        20.88
           -. For Gravity Load(DL+LL).
              My1G =        19.78,   My2G =        31.38
              Mz1G =        16.38,   Mz2G =        25.79
           -. For Total Load(DL+LL+WL(EL)).
              My1  =        19.78,   My2  =        31.38
              Mz1  =        17.59,   Mz2  =        26.64

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. Slenderness ratio limits.
              SRy(Braced)    =  34 + 12*MIN(|My1/My2|,0.5) =   40.000  (Reverse curvature)
              SRz(Braced)    =  34 + 12*MIN(|Mz1/Mz2|,0.5) =   40.000  (Reverse curvature)
```

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--------------------------------------------------------------------------------------
 midas Gen - RC-Column Design   [ NSR-10 ]                                Gen 2022
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           -. Radii of gyration.
              ry     =  0.30*Hc  =    0.090 m.
              rz     =  0.30*Bc  =    0.090 m.
           -. Unbraced lengths.
              Ly     =    3.300 m.
              Lz     =    3.300 m.
           -. Effective length factors.
              Ky     =    1.000
              Kz     =    1.000
           -. SLENy  =  Ky*Ly/ry  =   36.667  <=  SRy  --->  NOT SLENDER.
           -. SLENz  =  Kz*Lz/rz  =   36.667  <=  SRz  --->  NOT SLENDER.

      ( ). Moment magnification factors for major axis(DBy,DSy).
           -. DBy    =     1.00 (Default value)
           -. DSy    =     1.00 (Default value)

      ( ). Moment magnification factors for minor axis(DBz,DSz).
           -. DBz    =     1.00 (Default value)
           -. DSz    =     1.00 (Default value)

      ( ). Compute minimum moments(Mmin).
           -. emin_y  =  15 mm. + 0.03*Hc   =       0.024 m.
           -. emin_z  =  15 mm. + 0.03*Bc   =       0.024 m.
           -. Mmin_y  =  Pu * emin_y        =        1.37 kN-m.
           -. Mmin_z  =  Pu * emin_z        =        1.37 kN-m.

      ( ). Compute magnified moments. (Pos : J, Local-y : Braced, Local-z : Braced).
           -. No sidesway moments.
              QMb_y  =  My_G   =      -31.38 kN-m.
              QMb_z  =  Mz_G   =      -25.79 kN-m.
           -. Sidesway moments.
              QMs_y  =  My_S   =        0.00 kN-m.
              QMs_z  =  Mz_S   =       -0.85 kN-m.
           -. Compute magnified moments(Mcy,Mcz).
              Mcy(No-Slender) =  DBy*(QMb_y + QMs_y)              =      -31.38 kN-m.
              Mcz(No-Slender) =  DBz*(QMb_z + QMs_z)              =      -26.64 kN-m.

      ( ). Check total moment including 2nd-order effects.
           -. Moments due to 1st-order effects.
              Mcy-1st =        31.38 kN-m.
              Mcz-1st =        26.64 kN-m.
           -. Moments due to 2nd-order effects.
              Mcy-2nd = DBy*(QMb_y + QMs_y) =        31.38 kN-m.
              Mcz-2nd = DBz*(QMb_z + QMs_z) =        26.64 kN-m.
           -. Ratio of moment due to 2nd-order effects to moment due to 1st-order effects.
              Mcy-2nd / Mcy-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.
              Mcz-2nd / Mcz-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                    Gen 2022
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      ( ). Design forces/moments of column(brace).
           -. Axial Force (Compression)      Pu  =       57.23 kN.
           -. Combined Bending Moment        Mc  =       41.16 kN-m.
           -. Bending Moment about Local-y   Mcy =      -31.38 kN-m.
           -. Bending Moment about Local-z   Mcz =      -26.64 kN-m.
           -. Shear Force of Local-y         Vuy =       15.58 kN.
           -. Shear Force of Local-z         Vuz =       18.29 kN.

 ===============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC_COLUMN(RC-BRACE).
 ===============================================================================

      ( ). Compute design parameters.
           -. Ag     =              0.0900 m^2.
           -. Ast    =              0.0010 m^2.
           -. Rhot   = Ast/Ag =   0.011470
           -. esu    = fy/Es  =   0.002100
           -. beta1  =   0.8500  ( fc < 28 MPa.)

      ( ). Check the ratio of reinforcement.
           -. Rhomin =   0.010000
           -. Rhomax =   0.040000
           -. Rhot   =   0.011470
              Rhomin < Rhot < Rhomax  --->  O.K !

      ( ). Compute eccentricities of biaxially loaded column.
           -. Ecny   = ABS(Mcz/Pu)     =      0.4655 m.
           -. Ecnz   = ABS(Mcy/Pu)     =      0.5482 m.
           -. Eccn   = ABS(Mc/Pu)      =      0.7192 m.
           -. Rota   = ATAN(Ecny/Ecnz) =     40.3337 deg.
           -. Rotation of neutral axis =     40.3337 deg.

      ( ). Compute concentric axial load capacity.
           -. Po     = (0.85*fc)*(Ag-Ast) + fy*Ast    =     2021.62 kN.
           -. Maximum Axial Load    : Pomax = 0.75*Po =     1516.22 kN.
           -. Maximum Axial Tension : Pt    = -fy*Ast =     -433.55 kN.

     ----------------------------------------------------------------------------
       *. Analysis of balanced condition.
     ----------------------------------------------------------------------------

      ( ). Compute capacity of concrete stress block.
           -. cb     = (0.003/(0.003+esu))*d  =       0.216 m.
           -. ab     = beta1*cb               =       0.183 m.
           -. Acom                            =       0.034 m^2.
           -. DCcy                            =       0.056 m.
           -. DCcz                            =       0.070 m.
           -. Cc     = 0.85*fc*Acom           =      607.38 kN.
           -. MnCy   = Cc*DCcz                =       42.44 kN-m.
           -. MnCz   = Cc*DCcy                =       33.79 kN-m.
```

midas Gen - RC-Column Design [NSR-10] Gen 2022

( ). Compute capacity of reinforcement.

i	dsi	esi	fsi	Asi	Fsi	dzi	MnPyi	dyi	MnPzi
1	0.366	-0.002100	-420000.00	1.290e-04	-54.19	-0.110	5.96	-0.110	5.96
2	0.283	-0.000933	-186619.14	1.290e-04	-24.08	0.000	-0.00	-0.110	2.65
3	0.199	0.000234	46761.72	1.290e-04	6.03	0.110	0.66	-0.110	-0.66
4	0.128	0.001225	244919.32	1.290e-04	31.60	0.110	3.48	0.000	0.00
5	0.056	0.002215	420000.00	1.290e-04	54.19	0.110	5.96	0.110	5.96
6	0.140	0.001048	209696.06	1.290e-04	27.06	0.000	0.00	0.110	2.98
7	0.224	-0.000118	-23684.80	1.290e-04	-3.06	-0.110	0.34	0.110	-0.34
8	0.295	-0.001109	-221842.40	1.290e-04	-28.62	-0.110	3.15	0.000	-0.00

-.Where,
di = Distance from the section's neutral axis to the i-th reinforcement (m.)
esi = Strain in the i-th reinforcement
fsi = Stress in the i-th reinforcement (KPa.)
Asi = Cross-section area of the i-th reinforcement (m^2.)
Fsi = Tensile strength of the i-th reinforcement (kN.)
dzi = Distance from the center of the section to the i-th reinforcement in the element local z-axis (m.)
dyi = Distance from the center of the section to the i-th reinforcement in the element local y-axis (m.)
M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement (kN-m.)
M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement (kN-m.)

-. Ps = SUM [Fsi] = 8.93 kN.
-. MnPy = SUM [MnPyi] = 19.55 kN-m.
-. MnPz = SUM [MnPzi] = 16.55 kN-m.

( ). Compute nominal capacity(Pb,Mb) of Balanced Condition.
-. Pb = Cc + Ps = 616.31 kN.
-. Mny = MnCy + MnPy = 61.99 kN-m.
-. Mnz = MnCz + MnPz = 50.34 kN-m.
-. Mb = SQRT(Mny^2+Mnz^2) = 79.85 kN-m.

( ). Compare actual eccentricity with balanced eccentricity.
-. Balanced eccentricity : eb = Mb/Pb = 0.130 m.
-. Minimum eccentricity : Emin (not defined) = 0.000 m.
-. Actual eccentricity : Eccn = Mu/Pu = 0.719 m.
-. eb < Eccn ---> Tension controls.

*. Final analysis with searched neutral axis.

( ). Search for neutral axis...... Unit : kN., m.
-. P-M calculation method : Keep P constant

Trial	c	Phi*Pn	Pu	Ratio
1-st	0.148	104.69	57.234	54.67
2-nd	0.144	81.20	57.234	70.48
3-rd	0.142	68.98	57.234	82.97
4-th	0.140	62.73	57.234	91.23
5-th	0.140	59.58	57.234	96.06
6-th	0.140	57.99	57.234	98.69
7-th	0.139	57.20	57.234	99.94
8-th	0.140	57.59	57.234	99.37
9-th	0.140	57.40	57.234	99.72

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 midas Gen - RC-Column Design   [ NSR-10 ]                                      Gen 2022
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      ( ). Compute capacity of compression stress block.
           -. a      = beta1*c               =       0.119 m.
           -. Acom                           =       0.014 m^2.
           -. DCcy                           =       0.089 m.
           -. DCcz                           =       0.098 m.
           -. Cc     = 0.85*fc*Acom          =      254.47 kN.
           -. MnCy   = Cc*DCcz               =       24.97 kN-m.
           -. MnCz   = Cc*DCcy               =       22.63 kN-m.

      ( ). Compute capacity of reinforcement.
      ------------------------------------------------------------------------------------------------
       i      dsi       esi        fsi        Asi         Fsi      dzi       MnPyi      dyi       MnPzi
      ------------------------------------------------------------------------------------------------
       1    0.366 -0.004879 -420000.00  1.290e-04     -54.19   -0.110        5.96   -0.110        5.96
       2    0.283 -0.003076 -420000.00  1.290e-04     -54.19    0.000       -0.00   -0.110        5.96
       3    0.199 -0.001274 -254722.04  1.290e-04     -32.87    0.110       -3.62   -0.110        3.62
       4    0.128  0.000257   51420.31  1.290e-04       6.63    0.110        0.73    0.000        0.00
       5    0.056  0.001788  357562.67  1.290e-04      46.14    0.110        5.08    0.110        5.08
       6    0.140 -0.000015   -2997.64  1.290e-04      -0.39    0.000       -0.00    0.110       -0.04
       7    0.224 -0.001818 -363557.95  1.290e-04     -46.91   -0.110        5.16    0.110       -5.16
       8    0.295 -0.003349 -420000.00  1.290e-04     -54.19   -0.110        5.96    0.000       -0.00
      ------------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ----------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =     -189.97 kN.
           -. MnPy   = SUM [ MnPyi ]  =       19.27 kN-m.
           -. MnPz   = SUM [ MnPzi ]  =       15.41 kN-m.

      ( ). Compute nominal capacity(Pn,Mn) of given neutral axis.
           -. Pn     = Cc + Ps               =       64.49 kN.
           -. Mny    = MnCy + MnPy           =       44.24 kN-m.
           -. Mnz    = MnCz + MnPz           =       38.04 kN-m.
           -. Mn     = SQRT(Mny^2+Mnz^2)     =       58.35 kN-m.

      ( ). Compute strength reduction factor.
           -. et      = 0.00488
           -. et_min  = 0.00210
           -. et_max  = 0.00500
           -. et_min < et < et_max  --->  phi = 0.65 + (et-0.002)*(250/3) =0.890  (Ties).

      ( ). Compute axial load and moment capacities(phiPn,phiMn).
           -. phiPn  = phi*Pn  =       57.40 kN.
           -. phiMn  = phi*Mn  =       51.93 kN-m.
           -. phiMny = phi*Mny =       39.37 kN-m.
           -. phiMnz = phi*Mnz =       33.85 kN-m.

      ( ). Check ratios of axial load and moment capacity.
           -. Rat_P  = Pu/phiPn = 0.997  <  1.000  --->  O.K.
           -. Rat_M  = Mc/phiMn = 0.793  <  1.000  --->  O.K.

 ================================================================================
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PROJECT TITLE : Acueducto Agua Bonita - San José del Guaviare

MIDAS	**Company**	Leandro Castellanos	**Client**	
	Author	Leandro Castellanos	**File Name**	Caseta.rcs

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   [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN ( END ).
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 midas Gen - RC-Column Design   [ NSR-10 ]                                       Gen 2022
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      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.203 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   10,  POS = J )
           -. Applied axial force : Pu  =       57.19 kN.
           -. Applied shear force : Vuz =       18.29 kN.
           -. d      = Hc-do    =    0.260 m.
           -. Bw     = Bc       =    0.300 m.
           -. Acv    = Bw*d     =    0.078 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =       63.52 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =       47.64 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   21,  POS = J )
           -. Applied axial force : Pu  =       44.21 kN.
           -. Applied shear force : Vuy =       15.58 kN.
           -. d      = Bc-do    =    0.260 m.
           -. Bw     = Hc       =    0.300 m.
           -. Acv    = Bw*d     =    0.078 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =       62.90 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =       47.17 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.203 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   10,  POS = 1/2 )
           -. Applied axial force : Pu  =       61.46 kN.
           -. Applied shear force : Vuz =       18.29 kN.
           -. d      = Hc-do    =    0.260 m.
           -. Bw     = Bc       =    0.300 m.
           -. Acv    = Bw*d     =    0.078 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =       63.73 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =       47.80 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.
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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
============================================================================================


      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   21,  POS = 1/2 )
           -. Applied axial force : Pu  =       48.49 kN.
           -. Applied shear force : Vuy =       15.58 kN.
           -. d      = Bc-do    =    0.260 m.
           -. Bw     = Hc       =    0.300 m.
           -. Acv    = Bw*d     =    0.078 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =       63.10 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =       47.33 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.
      *.midas Gen - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita - San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = COLUMN ,  MEMB =     3,  LCB =   11,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     1) : C30*30
        Section Type : Rectangular with Ties (RT)
        Section Height (HTc)             =        3.300 m.
        Section Depth  (Hc)              =        0.300 m.
        Section Width  (Bc)              =        0.300 m.
        Concrete Cover to C.O.R. (do)    =        0.040 m.
        Concrete Strength (fc)           =    21000.000 KPa.
        Modulus of Elasticity (Ec)       =  21538105.766 KPa.
        Main Rebar Strength (fy)         =   420000.000 KPa.
        Ties/Spirals Strength (fys)      =   420000.000 KPa.
        Modulus of Elasticity (Es)       = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

     *.REBAR PATTERN = RT -  8 -  3 - #4          Unit :  m.
        -------------------------------------------------------
           i          dyi          dzi      Rebar          Asi
        -------------------------------------------------------
           1       -0.110       -0.110      1-#4       0.00013
           2       -0.110        0.000      1-#4       0.00013
           3       -0.110        0.110      1-#4       0.00013
           4        0.000        0.110      1-#4       0.00013
           5        0.110        0.110      1-#4       0.00013
           6        0.110        0.000      1-#4       0.00013
           7        0.110       -0.110      1-#4       0.00013
           8        0.000       -0.110      1-#4       0.00013
        -------------------------------------------------------

 ==============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =   11
           ---------------------------------------------------------------------------
            Load Case              Pu          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                  46.41        16.52       -25.29       -13.75        20.88
            LL                  10.50         3.25        -6.08        -2.64         4.92
            DL+LL               56.91        19.78       -31.38       -16.38        25.79
            Others               0.32         0.00         0.00        -1.20         0.85
           ---------------------------------------------------------------------------
            DL+LL+Others        57.23        19.78       -31.38       -17.59        26.64
           ---------------------------------------------------------------------------

      ( ). Compute member end moments(M1,M2).  Unit : kN-m.
           -. For Dead Load(DL).
              My1D =        16.52,   My2D =        25.29
              Mz1D =        13.75,   Mz2D =        20.88
           -. For Gravity Load(DL+LL).
              My1G =        19.78,   My2G =        31.38
              Mz1G =        16.38,   Mz2G =        25.79
           -. For Total Load(DL+LL+WL(EL)).
              My1  =        19.78,   My2  =        31.38
              Mz1  =        17.59,   Mz2  =        26.64

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. Slenderness ratio limits.
              SRy(Braced)   =  34 + 12*MIN(|My1/My2|,0.5) =   40.000  (Reverse curvature)
              SRz(Braced)   =  34 + 12*MIN(|Mz1/Mz2|,0.5) =   40.000  (Reverse curvature)
           -. Radii of gyration.
              ry     =  0.30*Hc  =    0.090 m.
              rz     =  0.30*Bc  =    0.090 m.
           -. Unbraced lengths.
              Ly     =    3.300 m.
              Lz     =    3.300 m.
           -. Effective length factors.
              Ky     =    1.000
              Kz     =    1.000
           -. SLENy  =  Ky*Ly/ry  =   36.667  <=  SRy  --->  NOT SLENDER.
           -. SLENz  =  Kz*Lz/rz  =   36.667  <=  SRz  --->  NOT SLENDER.

      ( ). Moment magnification factors for major axis(DBy,DSy).
           -. DBy    =     1.00 (Default value)
           -. DSy    =     1.00 (Default value)

      ( ). Moment magnification factors for minor axis(DBz,DSz).
           -. DBz    =     1.00 (Default value)
           -. DSz    =     1.00 (Default value)
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute minimum moments(Mmin).
           -. emin_y  =  15 mm. + 0.03*Hc   =       0.024 m.
           -. emin_z  =  15 mm. + 0.03*Bc   =       0.024 m.
           -. Mmin_y  =  Pu * emin_y        =        1.37 kN-m.
           -. Mmin_z  =  Pu * emin_z        =        1.37 kN-m.

      ( ). Compute magnified moments. (Pos : J, Local-y : Braced, Local-z : Braced).
           -. No sidesway moments.
              QMb_y  =  My_G   =      -31.38 kN-m.
              QMb_z  =  Mz_G   =       25.79 kN-m.
           -. Sidesway moments.
              QMs_y  =  My_S   =        0.00 kN-m.
              QMs_z  =  Mz_S   =        0.85 kN-m.
           -. Compute magnified moments(Mcy,Mcz).
              Mcy(No-Slender) =  DBy*(QMb_y + QMs_y)              =      -31.38 kN-m.
              Mcz(No-Slender) =  DBz*(QMb_z + QMs_z)              =       26.64 kN-m.

      ( ). Check total moment including 2nd-order effects.
           -. Moments due to 1st-order effects.
              Mcy-1st =        31.38 kN-m.
              Mcz-1st =        26.64 kN-m.
           -. Moments due to 2nd-order effects.
              Mcy-2nd = DBy*(QMb_y + QMs_y) =        31.38 kN-m.
              Mcz-2nd = DBz*(QMb_z + QMs_z) =        26.64 kN-m.
           -. Ratio of moment due to 2nd-order effects to moment due to 1st-order effects.
              Mcy-2nd / Mcy-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.
              Mcz-2nd / Mcz-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.

      ( ). Design forces/moments of column(brace).
           -. Axial Force (Compression)      Pu  =       57.23 kN.
           -. Combined Bending Moment        Mc  =       41.16 kN-m.
           -. Bending Moment about Local-y   Mcy =      -31.38 kN-m.
           -. Bending Moment about Local-z   Mcz =       26.64 kN-m.
           -. Shear Force of Local-y         Vuy =       15.58 kN.
           -. Shear Force of Local-z         Vuz =       18.29 kN.

 ===============================================================================
   [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC_COLUMN(RC-BRACE).
 ===============================================================================

      ( ). Compute design parameters.
           -. Ag     =              0.0900 m^2.
           -. Ast    =              0.0010 m^2.
           -. Rhot   = Ast/Ag =   0.011470
           -. esu    = fy/Es  =   0.002100
           -. beta1  =   0.8500  ( fc < 28 MPa.)
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midas Gen - RC-Column Design [NSR-10] Gen 2022

( ). Check the ratio of reinforcement.
-. Rhomin = 0.010000
-. Rhomax = 0.040000
-. Rhot = 0.011470
Rhomin < Rhot < Rhomax ---> O.K !

( ). Compute eccentricities of biaxially loaded column.
-. Ecny = ABS(Mcz/Pu) = 0.4655 m.
-. Ecnz = ABS(Mcy/Pu) = 0.5482 m.
-. Eccn = ABS(Mc/Pu) = 0.7192 m.
-. Rota = ATAN(Ecny/Ecnz) = 40.3337 deg.
-. Rotation of neutral axis = 40.3337 deg.

( ). Compute concentric axial load capacity.
-. Po = (0.85*fc)*(Ag-Ast) + fy*Ast = 2021.62 kN.
-. Maximum Axial Load : Pomax = 0.75*Po = 1516.22 kN.
-. Maximum Axial Tension : Pt = -fy*Ast = -433.55 kN.

*. Analysis of balanced condition.

( ). Compute capacity of concrete stress block.
-. cb = (0.003/(0.003+esu))*d = 0.216 m.
-. ab = beta1*cb = 0.183 m.
-. Acom = 0.034 m^2.
-. DCcy = 0.056 m.
-. DCcz = 0.070 m.
-. Cc = 0.85*fc*Acom = 607.38 kN.
-. MnCy = Cc*DCcz = 42.44 kN-m.
-. MnCz = Cc*DCcy = 33.79 kN-m.

( ). Compute capacity of reinforcement.

i	dsi	esi	fsi	Asi	Fsi	dzi	MnPyi	dyi	MnPzi
1	0.366	-0.002100	-420000.00	1.290e-04	-54.19	-0.110	5.96	-0.110	5.96
2	0.283	-0.000933	-186619.14	1.290e-04	-24.08	0.000	-0.00	-0.110	2.65
3	0.199	0.000234	46761.72	1.290e-04	6.03	0.110	0.66	-0.110	-0.66
4	0.128	0.001225	244919.32	1.290e-04	31.60	0.110	3.48	0.000	0.00
5	0.056	0.002215	420000.00	1.290e-04	54.19	0.110	5.96	0.110	5.96
6	0.140	0.001048	209696.06	1.290e-04	27.06	0.000	0.00	0.110	2.98
7	0.224	-0.000118	-23684.80	1.290e-04	-3.06	-0.110	0.34	0.110	-0.34
8	0.295	-0.001109	-221842.40	1.290e-04	-28.62	-0.110	3.15	0.000	-0.00

-.Where,
di = Distance from the section's neutral axis to the i-th reinforcement (m.)
esi = Strain in the i-th reinforcement
fsi = Stress in the i-th reinforcement (KPa.)
Asi = Cross-section area of the i-th reinforcement (m^2.)
Fsi = Tensile strength of the i-th reinforcement (kN.)
dzi = Distance from the center of the section to the i-th reinforcement in the element local z-axis (m.)
dyi = Distance from the center of the section to the i-th reinforcement in the element local y-axis (m.)
M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement (kN-m.)
M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement (kN-m.)

-. Ps = SUM [Fsi] = 8.93 kN.
-. MnPy = SUM [MnPyi] = 19.55 kN-m.
-. MnPz = SUM [MnPzi] = 16.55 kN-m.

PROJECT TITLE : Acueducto Agua Bonita - San José del Guaviare

	Company	Leandro Castellanos	**Client**	
	Author	Leandro Castellanos	**File Name**	Caseta.rcs

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute nominal capacity(Pb,Mb) of Balanced Condition.
           -. Pb      = Cc + Ps               =       616.31 kN.
           -. Mny     = MnCy + MnPy           =        61.99 kN-m.
           -. Mnz     = MnCz + MnPz           =        50.34 kN-m.
           -. Mb      = SQRT(Mny^2+Mnz^2)     =        79.85 kN-m.

      ( ). Compare actual eccentricity with balanced eccentricity.
           -. Balanced eccentricity : eb   = Mb/Pb         =    0.130 m.
           -. Minimum eccentricity  : Emin (not defined)  =    0.000 m.
           -. Actual eccentricity   : Eccn = Mu/Pu         =    0.719 m.
           -. eb   < Eccn       --->  Tension controls.

     -----------------------------------------------------------------------------
       *. Final analysis with searched neutral axis.
     -----------------------------------------------------------------------------

      ( ). Search for neutral axis......     Unit :  kN.,  m.
           -. P-M calculation method : Keep P constant
          -----------------------------------------------------
           Trial          c        Phi*Pn        Pu       Ratio
          -----------------------------------------------------
            1-st      0.148      104.69      57.234     54.67
            2-nd      0.144       81.20      57.234     70.48
            3-rd      0.142       68.98      57.234     82.97
            4-th      0.140       62.73      57.234     91.23
            5-th      0.140       59.58      57.234     96.06
            6-th      0.140       57.99      57.234     98.69
            7-th      0.139       57.20      57.234     99.94
            8-th      0.140       57.59      57.234     99.37
            9-th      0.140       57.40      57.234     99.72
          -----------------------------------------------------

      ( ). Compute capacity of compression stress block.
           -. a       = beta1*c               =        0.119 m.
           -. Acom                            =        0.014 m^2.
           -. DCcy                            =        0.089 m.
           -. DCcz                            =        0.098 m.
           -. Cc      = 0.85*fc*Acom          =       254.47 kN.
           -. MnCy    = Cc*DCcz               =        24.97 kN-m.
           -. MnCz    = Cc*DCcy               =        22.63 kN-m.

      ( ). Compute capacity of reinforcement.
      -------------------------------------------------------------------------------------------------
       i      dsi       esi          fsi         Asi          Fsi       dzi        MnPyi       dyi        MnPzi
      -------------------------------------------------------------------------------------------------
       1    0.366 -0.004879 -420000.00  1.290e-04     -54.19   -0.110       5.96   -0.110       5.96
       2    0.283 -0.003076 -420000.00  1.290e-04     -54.19    0.000      -0.00   -0.110       5.96
       3    0.199 -0.001274 -254722.04  1.290e-04     -32.87    0.110      -3.62   -0.110       3.62
       4    0.128  0.000257   51420.31  1.290e-04       6.63    0.110       0.73    0.000       0.00
       5    0.056  0.001788  357562.67  1.290e-04      46.14    0.110       5.08    0.110       5.08
       6    0.140 -0.000015   -2997.64  1.290e-04      -0.39    0.000      -0.00    0.110      -0.04
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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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       7    0.224 -0.001818 -363557.95  1.290e-04     -46.91   -0.110        5.16    0.110       -5.16
       8    0.295 -0.003349 -420000.00  1.290e-04     -54.19   -0.110        5.96    0.000       -0.00
      ----------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ----------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =     -189.97 kN.
           -. MnPy   = SUM [ MnPyi ]  =       19.27 kN-m.
           -. MnPz   = SUM [ MnPzi ]  =       15.41 kN-m.

      ( ). Compute nominal capacity(Pn,Mn) of given neutral axis.
           -. Pn     = Cc + Ps                  =       64.49 kN.
           -. Mny    = MnCy + MnPy              =       44.24 kN-m.
           -. Mnz    = MnCz + MnPz              =       38.04 kN-m.
           -. Mn     = SQRT(Mny^2+Mnz^2)        =       58.35 kN-m.

      ( ). Compute strength reduction factor.
           -. et      = 0.00488
           -. et_min  = 0.00210
           -. et_max  = 0.00500
           -. et_min < et < et_max  --->  phi = 0.65 + (et-0.002)*(250/3) =0.890  (Ties).

      ( ). Compute axial load and moment capacities(phiPn,phiMn).
           -. phiPn  = phi*Pn  =       57.40 kN.
           -. phiMn  = phi*Mn  =       51.93 kN-m.
           -. phiMny = phi*Mny =       39.37 kN-m.
           -. phiMnz = phi*Mnz =       33.85 kN-m.

      ( ). Check ratios of axial load and moment capacity.
           -. Rat_P  = Pu/phiPn = 0.997  <  1.000  --->  O.K.
           -. Rat_M  = Mc/phiMn = 0.793  <  1.000  --->  O.K.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.203 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   10,  POS = J )
           -. Applied axial force : Pu  =       57.19 kN.
           -. Applied shear force : Vuz =       18.29 kN.
           -. d      = Hc-do    =    0.260 m.
           -. Bw     = Bc       =    0.300 m.
           -. Acv    = Bw*d     =    0.078 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =       63.52 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =       47.64 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.
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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   25,  POS = J )
           -. Applied axial force : Pu  =       48.61 kN.
           -. Applied shear force : Vuy =       15.58 kN.
           -. d      = Bc-do    =    0.260 m.
           -. Bw     = Hc       =    0.300 m.
           -. Acv    = Bw*d     =    0.078 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =       63.11 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =       47.33 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.203 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   10,  POS = 1/2 )
           -. Applied axial force : Pu  =       61.46 kN.
           -. Applied shear force : Vuz =       18.29 kN.
           -. d      = Hc-do    =    0.260 m.
           -. Bw     = Bc       =    0.300 m.
           -. Acv    = Bw*d     =    0.078 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =       63.73 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =       47.80 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   25,  POS = 1/2 )
           -. Applied axial force : Pu  =       52.88 kN.
           -. Applied shear force : Vuy =       15.58 kN.
           -. d      = Bc-do    =    0.260 m.
           -. Bw     = Hc       =    0.300 m.
           -. Acv    = Bw*d     =    0.078 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =       63.32 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =       47.49 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.
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 midas Gen - RC-Column Design   [ NSR-10 ]                              Gen 2022
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      *.midas Gen - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       : Acueducto Agua Bonita - San José del Guaviare
      *.DESIGN CODE   : NSR-10,         *.UNIT SYSTEM : kN, m
        (Note. Nonhomogenous equation in the code are written in SI units in the report)
      *.MEMBER        : Member Type = COLUMN ,  MEMB =     4,  LCB =   11,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     1) : C30*30
        Section Type : Rectangular with Ties (RT)
        Section Height (HTc)            =         3.300 m.
        Section Depth  (Hc)             =         0.300 m.
        Section Width  (Bc)             =         0.300 m.
        Concrete Cover to C.O.R. (do)   =         0.040 m.
        Concrete Strength (fc)          =     21000.000 KPa.
        Modulus of Elasticity (Ec)      =  21538105.766 KPa.
        Main Rebar Strength (fy)        =    420000.000 KPa.
        Ties/Spirals Strength (fys)     =    420000.000 KPa.
        Modulus of Elasticity (Es)      = 200000000.000 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Minimum Energy Dissipation (DMI).

     *.REBAR PATTERN = RT -  8 -  3 - #4         Unit :  m.
        --------------------------------------------------------
           i          dyi          dzi      Rebar          Asi
        --------------------------------------------------------
           1       -0.110       -0.110      1-#4       0.00013
           2       -0.110        0.000      1-#4       0.00013
           3       -0.110        0.110      1-#4       0.00013
           4        0.000        0.110      1-#4       0.00013
           5        0.110        0.110      1-#4       0.00013
           6        0.110        0.000      1-#4       0.00013
           7        0.110       -0.110      1-#4       0.00013
           8        0.000       -0.110      1-#4       0.00013
        --------------------------------------------------------

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

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =   11
           ---------------------------------------------------------------------------
            Load Case              Pu          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                  46.41       -16.52        25.29       -13.75        20.88
            LL                  10.50        -3.25         6.08        -2.64         4.92
            DL+LL               56.91       -19.78        31.38       -16.38        25.79
            Others               0.32         0.00         0.00        -1.20         0.85
           ---------------------------------------------------------------------------
            DL+LL+Others        57.23       -19.78        31.38       -17.59        26.64
           ---------------------------------------------------------------------------
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Compute member end moments(M1,M2).  Unit : kN-m.
           -. For Dead Load(DL).
              My1D =        16.52,   My2D =        25.29
              Mz1D =        13.75,   Mz2D =        20.88
           -. For Gravity Load(DL+LL).
              My1G =        19.78,   My2G =        31.38
              Mz1G =        16.38,   Mz2G =        25.79
           -. For Total Load(DL+LL+WL(EL)).
              My1  =        19.78,   My2  =        31.38
              Mz1  =        17.59,   Mz2  =        26.64

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. Slenderness ratio limits.
              SRy(Braced)    =  34 + 12*MIN(|My1/My2|,0.5) =   40.000  (Reverse curvature)
              SRz(Braced)    =  34 + 12*MIN(|Mz1/Mz2|,0.5) =   40.000  (Reverse curvature)
           -. Radii of gyration.
              ry     =  0.30*Hc  =    0.090 m.
              rz     =  0.30*Bc  =    0.090 m.
           -. Unbraced lengths.
              Ly     =    3.300 m.
              Lz     =    3.300 m.
           -. Effective length factors.
              Ky     =    1.000
              Kz     =    1.000
           -. SLENy  =  Ky*Ly/ry  =   36.667  <=  SRy  --->  NOT SLENDER.
           -. SLENz  =  Kz*Lz/rz  =   36.667  <=  SRz  --->  NOT SLENDER.

      ( ). Moment magnification factors for major axis(DBy,DSy).
           -. DBy    =     1.00 (Default value)
           -. DSy    =     1.00 (Default value)

      ( ). Moment magnification factors for minor axis(DBz,DSz).
           -. DBz    =     1.00 (Default value)
           -. DSz    =     1.00 (Default value)

      ( ). Compute minimum moments(Mmin).
           -. emin_y  =  15 mm. + 0.03*Hc   =       0.024 m.
           -. emin_z  =  15 mm. + 0.03*Bc   =       0.024 m.
           -. Mmin_y  =  Pu * emin_y        =        1.37 kN-m.
           -. Mmin_z  =  Pu * emin_z        =        1.37 kN-m.

      ( ). Compute magnified moments. (Pos : J, Local-y : Braced, Local-z : Braced).
           -. No sidesway moments.
              QMb_y  =  My_G   =       31.38 kN-m.
              QMb_z  =  Mz_G   =       25.79 kN-m.
           -. Sidesway moments.
              QMs_y  =  My_S   =        0.00 kN-m.
              QMs_z  =  Mz_S   =        0.85 kN-m.
           -. Compute magnified moments(Mcy,Mcz).
              Mcy(No-Slender) =  DBy*(QMb_y + QMs_y)              =       31.38 kN-m.
              Mcz(No-Slender) =  DBz*(QMb_z + QMs_z)              =       26.64 kN-m.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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      ( ). Check total moment including 2nd-order effects.
           -. Moments due to 1st-order effects.
              Mcy-1st =         31.38 kN-m.
              Mcz-1st =         26.64 kN-m.
           -. Moments due to 2nd-order effects.
              Mcy-2nd = DBy*(QMb_y + QMs_y) =         31.38 kN-m.
              Mcz-2nd = DBz*(QMb_z + QMs_z) =         26.64 kN-m.
           -. Ratio of moment due to 2nd-order effects to moment due to 1st-order effects.
              Mcy-2nd / Mcy-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.
              Mcz-2nd / Mcz-1st =  1.0000 <= 1.4 --->  O.K ! Apply magnified moment.

      ( ). Design forces/moments of column(brace).
           -. Axial Force (Compression)      Pu  =       57.23 kN.
           -. Combined Bending Moment        Mc  =       41.16 kN-m.
           -. Bending Moment about Local-y   Mcy =       31.38 kN-m.
           -. Bending Moment about Local-z   Mcz =       26.64 kN-m.
           -. Shear Force of Local-y         Vuy =       15.58 kN.
           -. Shear Force of Local-z         Vuz =       18.29 kN.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC_COLUMN(RC-BRACE).
 ================================================================================

      ( ). Compute design parameters.
           -. Ag     =              0.0900 m^2.
           -. Ast    =              0.0010 m^2.
           -. Rhot   = Ast/Ag =   0.011470
           -. esu    = fy/Es  =   0.002100
           -. beta1  =   0.8500  ( fc < 28 MPa.)

      ( ). Check the ratio of reinforcement.
           -. Rhomin =   0.010000
           -. Rhomax =   0.040000
           -. Rhot   =   0.011470
              Rhomin < Rhot < Rhomax  --->  O.K !

      ( ). Compute eccentricities of biaxially loaded column.
           -. Ecny   = ABS(Mcz/Pu)     =      0.4655 m.
           -. Ecnz   = ABS(Mcy/Pu)     =      0.5482 m.
           -. Eccn   = ABS(Mc/Pu)      =      0.7192 m.
           -. Rota   = ATAN(Ecny/Ecnz) =     40.3337 deg.
           -. Rotation of neutral axis =     40.3337 deg.

      ( ). Compute concentric axial load capacity.
           -. Po     = (0.85*fc)*(Ag-Ast) + fy*Ast    =     2021.62 kN.
           -. Maximum Axial Load    : Pomax = 0.75*Po =     1516.22 kN.
           -. Maximum Axial Tension : Pt    = -fy*Ast =     -433.55 kN.
```

PROJECT TITLE : Acueducto Agua Bonita - San José del Guaviare

MIDAS	**Company**	Leandro Castellanos	**Client**	
	Author	Leandro Castellanos	**File Name**	Caseta.rcs

midas Gen - RC-Column Design [NSR-10] Gen 2022

*. Analysis of balanced condition.

( ). Compute capacity of concrete stress block.

-. cb = (0.003/(0.003+esu))*d = 0.216 m.
-. ab = beta1*cb = 0.183 m.
-. Acom = 0.034 m^2.
-. DCcy = 0.056 m.
-. DCcz = 0.070 m.
-. Cc = 0.85*fc*Acom = 607.38 kN.
-. MnCy = Cc*DCcz = 42.44 kN-m.
-. MnCz = Cc*DCcy = 33.79 kN-m.

( ). Compute capacity of reinforcement.

i	dsi	esi	fsi	Asi	Fsi	dzi	MnPyi	dyi	MnPzi
1	0.366	-0.002100	-420000.00	1.290e-04	-54.19	-0.110	5.96	-0.110	5.96
2	0.283	-0.000933	-186619.14	1.290e-04	-24.08	0.000	-0.00	-0.110	2.65
3	0.199	0.000234	46761.72	1.290e-04	6.03	0.110	0.66	-0.110	-0.66
4	0.128	0.001225	244919.32	1.290e-04	31.60	0.110	3.48	0.000	0.00
5	0.056	0.002215	420000.00	1.290e-04	54.19	0.110	5.96	0.110	5.96
6	0.140	0.001048	209696.06	1.290e-04	27.06	0.000	0.00	0.110	2.98
7	0.224	-0.000118	-23684.80	1.290e-04	-3.06	-0.110	0.34	0.110	-0.34
8	0.295	-0.001109	-221842.40	1.290e-04	-28.62	-0.110	3.15	0.000	-0.00

-.Where,
di = Distance from the section's neutral axis to the i-th reinforcement (m.)
esi = Strain in the i-th reinforcement
fsi = Stress in the i-th reinforcement (KPa.)
Asi = Cross-section area of the i-th reinforcement (m^2.)
Fsi = Tensile strength of the i-th reinforcement (kN.)
dzi = Distance from the center of the section to the i-th reinforcement in the element local z-axis (m.)
dyi = Distance from the center of the section to the i-th reinforcement in the element local y-axis (m.)
M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement (kN-m.)
M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement (kN-m.)

-. Ps = SUM [Fsi] = 8.93 kN.
-. MnPy = SUM [MnPyi] = 19.55 kN-m.
-. MnPz = SUM [MnPzi] = 16.55 kN-m.

( ). Compute nominal capacity(Pb,Mb) of Balanced Condition.

-. Pb = Cc + Ps = 616.31 kN.
-. Mny = MnCy + MnPy = 61.99 kN-m.
-. Mnz = MnCz + MnPz = 50.34 kN-m.
-. Mb = SQRT(Mny^2+Mnz^2) = 79.85 kN-m.

( ). Compare actual eccentricity with balanced eccentricity.

-. Balanced eccentricity : eb = Mb/Pb = 0.130 m.
-. Minimum eccentricity : Emin (not defined) = 0.000 m.
-. Actual eccentricity : Eccn = Mu/Pu = 0.719 m.
-. eb < Eccn ---> Tension controls.

*. Final analysis with searched neutral axis.

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 midas Gen - RC-Column Design   [ NSR-10 ]                                   Gen 2022
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      ( ). Search for neutral axis......     Unit :  kN.,  m.
           -. P-M calculation method : Keep P constant
          -----------------------------------------------------
           Trial          c       Phi*Pn       Pu       Ratio
          -----------------------------------------------------
            1-st      0.148       104.69      57.234     54.67
            2-nd      0.144        81.20      57.234     70.48
            3-rd      0.142        68.98      57.234     82.97
            4-th      0.140        62.73      57.234     91.23
            5-th      0.140        59.58      57.234     96.06
            6-th      0.140        57.99      57.234     98.69
            7-th      0.139        57.20      57.234     99.94
            8-th      0.140        57.59      57.234     99.37
            9-th      0.140        57.40      57.234     99.72
          -----------------------------------------------------

      ( ). Compute capacity of compression stress block.
           -. a      = beta1*c               =       0.119 m.
           -. Acom                           =       0.014 m^2.
           -. DCcy                           =       0.089 m.
           -. DCcz                           =       0.098 m.
           -. Cc     = 0.85*fc*Acom          =      254.47 kN.
           -. MnCy   = Cc*DCcz               =       24.97 kN-m.
           -. MnCz   = Cc*DCcy               =       22.63 kN-m.

      ( ). Compute capacity of reinforcement.
      -------------------------------------------------------------------------------------------------
       i      dsi       esi         fsi         Asi         Fsi      dzi       MnPyi      dyi       MnPzi
      -------------------------------------------------------------------------------------------------
       1    0.366 -0.004879 -420000.00  1.290e-04     -54.19   -0.110       5.96   -0.110        5.96
       2    0.283 -0.003076 -420000.00  1.290e-04     -54.19    0.000      -0.00   -0.110        5.96
       3    0.199 -0.001274 -254722.04  1.290e-04     -32.87    0.110      -3.62   -0.110        3.62
       4    0.128  0.000257   51420.31  1.290e-04       6.63    0.110       0.73    0.000        0.00
       5    0.056  0.001788  357562.67  1.290e-04      46.14    0.110       5.08    0.110        5.08
       6    0.140 -0.000015   -2997.64  1.290e-04      -0.39    0.000      -0.00    0.110       -0.04
       7    0.224 -0.001818 -363557.95  1.290e-04     -46.91   -0.110       5.16    0.110       -5.16
       8    0.295 -0.003349 -420000.00  1.290e-04     -54.19   -0.110       5.96    0.000       -0.00
      -------------------------------------------------------------------------------------------------
      -.Where,
        di  = Distance from the section's neutral axis to the i-th reinforcement ( m.)
        esi = Strain in the i-th reinforcement
        fsi = Stress in the i-th reinforcement ( KPa.)
        Asi = Cross-section area of the i-th reinforcement ( m^2.)
        Fsi = Tensile strength of the i-th reinforcement ( kN.)
        dzi = Distance from the center of the section to the i-th reinforcement in the element local z-ax
is ( m.)
        dyi = Distance from the center of the section to the i-th reinforcement in the element local y-ax
is ( m.)
        M_nPyi = Flexural strength about the element local y-axes in the i-th reinforcement ( kN-m.)
        M_nPzi = Flexural strength about the element local z-axes in the i-th reinforcement ( kN-m.)
      ----------------------------------------------------------------------------------------------------
-----------
           -. Ps     = SUM [ Fsi ]    =     -189.97 kN.
           -. MnPy   = SUM [ MnPyi ]  =       19.27 kN-m.
           -. MnPz   = SUM [ MnPzi ]  =       15.41 kN-m.

      ( ). Compute nominal capacity(Pn,Mn) of given neutral axis.
           -. Pn     = Cc + Ps               =       64.49 kN.
           -. Mny    = MnCy + MnPy           =       44.24 kN-m.
           -. Mnz    = MnCz + MnPz           =       38.04 kN-m.
           -. Mn     = SQRT(Mny^2+Mnz^2)     =       58.35 kN-m.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                 Gen 2022
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      ( ). Compute strength reduction factor.
           -. et      = 0.00488
           -. et_min  = 0.00210
           -. et_max  = 0.00500
           -. et_min < et < et_max  --->  phi = 0.65 + (et-0.002)*(250/3) =0.890  (Ties).

      ( ). Compute axial load and moment capacities(phiPn,phiMn).
           -. phiPn  = phi*Pn  =       57.40 kN.
           -. phiMn  = phi*Mn  =       51.93 kN-m.
           -. phiMny = phi*Mny =       39.37 kN-m.
           -. phiMnz = phi*Mnz =       33.85 kN-m.

      ( ). Check ratios of axial load and moment capacity.
           -. Rat_P  = Pu/phiPn = 0.997  <  1.000  --->  O.K.
           -. Rat_M  = Mc/phiMn = 0.793  <  1.000  --->  O.K.

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

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.203 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   12,  POS = J )
           -. Applied axial force : Pu  =       57.19 kN.
           -. Applied shear force : Vuz =       18.29 kN.
           -. d      = Hc-do    =    0.260 m.
           -. Bw     = Bc       =    0.300 m.
           -. Acv    = Bw*d     =    0.078 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =       63.52 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =       47.64 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   22,  POS = J )
           -. Applied axial force : Pu  =       48.61 kN.
           -. Applied shear force : Vuy =       15.58 kN.
           -. d      = Bc-do    =    0.260 m.
           -. Bw     = Hc       =    0.300 m.
           -. Acv    = Bw*d     =    0.078 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =       63.11 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =       47.33 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.
```

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 midas Gen - RC-Column Design   [ NSR-10 ]                                  Gen 2022
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 ===============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN ( MIDDLE ).
 ===============================================================================

      ( ). Compute maximum spacing of ties.
           -. smax   = MIN[ 16*Dbar, 48*Dstir, Hc, Bc ] =    0.203 m.

      ( ). Compute concrete shear strength in local-z direction.
           ( LCB =   12,  POS = 1/2 )
           -. Applied axial force : Pu  =       61.46 kN.
           -. Applied shear force : Vuz =       18.29 kN.
           -. d      = Hc-do    =    0.260 m.
           -. Bw     = Bc       =    0.300 m.
           -. Acv    = Bw*d     =    0.078 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =       63.73 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =       47.80 kN.
           -. Vuz  <  phiVc/2  --->  Shear reinforcement is not required.

      ( ). Compute concrete shear strength in local-y direction.
           ( LCB =   22,  POS = 1/2 )
           -. Applied axial force : Pu  =       52.88 kN.
           -. Applied shear force : Vuy =       15.58 kN.
           -. d      = Bc-do    =    0.260 m.
           -. Bw     = Hc       =    0.300 m.
           -. Acv    = Bw*d     =    0.078 m^2.
           -. Vc     = 0.17*(1+Pu/(14*Ag))*SQRT(fc)*Acv =       63.32 kN.
           -. phi    = 0.75
           -. phiVc  = phi*Vc   =       47.49 kN.
           -. Vuy  <  phiVc/2  --->  Shear reinforcement is not required.
```

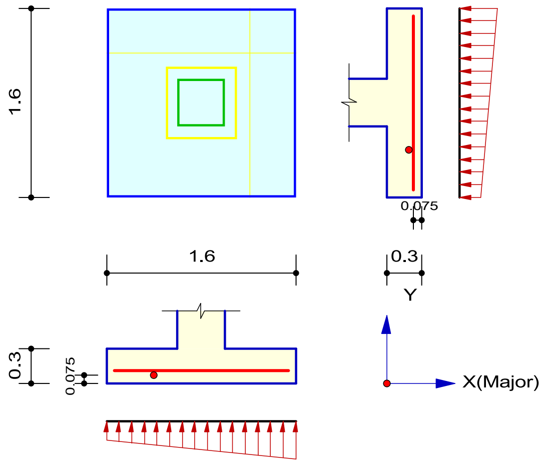
Company	Leandro Castellanos	**Project Title**	Acueducto Agua Bonita - San José d
Author	Leandro Castellanos	**File Name**	C:\...\Memorias\Modelos\Caseta.mgb

1. Geometry and Materials

Material : fc' = 21000, fy = 420000 kN/m^2

Dim. : 1.6 * 1.6 * 0.3 m (Dc = 0.075 m)

Allow. Soil Qe = 294.2 kN/m^2



2. Design Condition

Design Code : ACI318-02

Selected Node No. 12

Design Node No : 12 (Column Size: 0.4*0.4 m)

Design Load Combination

Service : 44 [fLCB44 : (D) + 0.7SRSS5]

Factored : 18 [fLCB18 : 1.2D + 1.0SRSS5]

Applied Loads

Ps = 135.309, Pu = 163.242 kN

Msx = 11.4862, Mux = 14.7055 kN-m

Msy = 13.0854, Muy = 16.8053 kN-m

3. Soil Bearing Pressure Check

Actual Pressure

Qs(max) = 96.0484 kN/m^2 < Qe = 294.200 kN/m^2 .... O.K

Qs(min) = 24.0615 kN/m^2 > 0.00 kN/m^2 .... O.K

Design Pressure

Qu(max) = 109.925 kN/m^2

Qu(min) = 17.6080 kN/m^2

4. Shear Check (Phi= 0.75)

One Way Shear

Vuy = 48.1553 kN < PhiVny = 205.474 kN .... O.K

Vux = 51.1259 kN < PhiVnx = 193.876 kN .... O.K

Punching Shear

Vu = 138.839 kN < PhiVn = 617.649 kN .... O.K

5. Bending Moment Check (Phi= 0.90)

X-X Axis (Y Direction)

	Required Space	Max. Space
Mux = 14.3860 kN-m/m		
Rho = 0.0008	#4 @ 750	#4 @ 240
As = 0.00017 m^2/m	#5 @ 1170	#5 @ 370
As(min) = 0.0018*D = 0.00053 m^2/m	#6 @ 1660	#6 @ 457

Y-Y Axis (X Direction)

	Required Space	Max. Space
Muy = 14.8013 kN-m/m		
Rho = 0.0009	#4 @ 690	#4 @ 240
As = 0.00019 m^2/m	#5 @ 1070	#5 @ 370
As(min) = 0.0018*D = 0.00053 m^2/m	#6 @ 1520	#6 @ 457