Detailed Member Calculations

Units: N& mm

Regulation: ASCE 41-17

Calculation No. 1

column C1, Floor 1

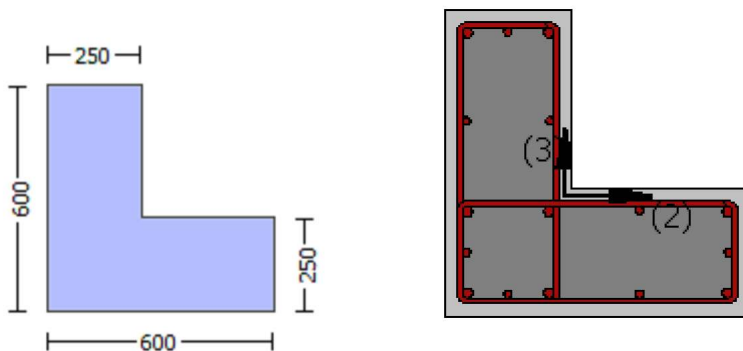Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (2)

Start Of Calculation of Shear Capacity for element: column LC1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rclcs

Constant Properties

Knowledge Factor,   = 1.00
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 21019.039

Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of y for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE41-17).
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.44
##
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min =lb/ld = 0.30
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -1.2874E+007
Shear Force, Va = -4235.571
EDGE -B-
Bending Moment, Mb = 163326.01
Shear Force, Vb = 4235.571
BOTH EDGES
Axial Force, F = -9654.265
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 4121.77
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1746.726
     -Compression: Asl,com = 829.3805
         -Middle: Asl,mid = 1545.664
Mean Diameter of Tension Reinforcement, DbL,ten = 17.71429

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR =   *Vn = 379610.938
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 379610.938
   VCol = 379610.938
   knl = 1.00
      displacement_ductility_demand = 0.01980051

NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

    = 1 (normal-weight concrete)
  fc' = 16.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
     Mu = 1.2874E+007
     Vu = 4235.571
  d = 0.8*h = 480.00
  Nu = 9654.265
  Ag = 150000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 427256.601
  where:
  Vs1 = 125663.706 is calculated for section web, with:
    d = 200.00
    Av = 157079.633

```
        fy = 400.00
        s = 100.00
     Vs1 is multiplied by   Col1 = 1.00
        s/d = 0.50
     Vs2 = 301592.895 is calculated for section flange, with:
        d = 480.00
        Av = 157079.633
        fy = 400.00
        s = 100.00
     Vs2 is multiplied by   Col2 = 1.00
        s/d = 0.20833333
     Vf ((11-3)-(11.4), ACI 440) = 0.00
     From (11-11), ACI 440: Vs + Vf <= 318865.838
        bw = 250.00
-----------------------------------------------------------

-----------------------------------------------------------
displacement_ductility_demand is calculated as   / y

 - Calculation of   / y for END A -
 for rotation axis 3 and integ. section (a)
-----------------------------------------------------------
From analysis, chord rotation    = 0.00012588
  y = (My*Ls/3)/EIeff = 0.00635746 ((4.29),Biskinis Phd))
   My = 2.6304E+008
   Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3039.576
   From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 4.1921E+013
      factor = 0.30
         Ag = 237500.00
         fc' = 20.00
         N = 9654.265
      Ec*Ig = 1.3974E+014
-----------------------------------------------------------
-----------------------------------------------------------

Calculation of Yielding Moment My
-----------------------------------------------------------
Calculation of   y and My according to Annex 7   -
-----------------------------------------------------------
  y = Min(  y_ten,  y_com)
  y_ten = 3.6312890E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 248.9644
      d = 557.00
       y = 0.38455208
      A = 0.02987826
      B = 0.0192605
       with pt = 0.01254381
          pc = 0.00595605
          pv = 0.01109992
          N = 9654.265
          b = 250.00
           " = 0.07719928
  y_comp = 8.0241107E-006
 with fc = 20.00
      Ec = 21019.039
       y = 0.38321062
      A = 0.02939738
      B = 0.01898202
       with Es = 200000.00
-----------------------------------------------------------
-----------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
-----------------------------------------------------------
End Of Calculation of Shear Capacity for element: column LC1 of floor 1
```

At local axis: 2
Integration Section: (a)

Calculation No. 2

column C1, Floor 1

Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (u)

Edge: Start

Local Axis: (2)

Start Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rclcs

Constant Properties

Knowledge Factor,   = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55
##
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.00

4

Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = 0.00016213
EDGE -B-
Shear Force, Vb = -0.00016213
BOTH EDGES
Axial Force, F = -8883.864
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
    -Compression: Aslc = 4121.77
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 1746.726
    -Compression: Asl,com = 829.3805
       -Middle: Asl,mid = 1545.664

Calculation of Shear Capacity ratio , Ve/Vr = 0.66001051
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 279996.052
with
Mpr1 = Max(Mu1+ , Mu1-) = 4.1999E+008
   Mu1+ = 4.1999E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
   Mu1- = 2.3955E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 4.1999E+008
   Mu2+ = 4.1999E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
   Mu2- = 2.3955E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.3683047E-005
Mu = 4.1999E+008
----
with full section properties:
  b = 250.00
  d = 557.00
  d' = 43.00
  v = 0.0031899
    N = 8883.864
  fc = 20.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00768077
      we (5.4c) = 0.01092426
       ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783

The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to   bi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00

----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00

----
s = 100.00
fywe = 555.55
fce = 20.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00129669
sh1 = 0.0044814
ft1 = 373.4467
fy1 = 311.2056
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 311.2056
with Es1 = Es = 200000.00
y2 = 0.00129669
sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 311.2056
with Es2 = Es = 200000.00
yv = 0.00129669
shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
suv = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
 suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
 y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
 with fsv = fs = 311.2056
 with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.19518516
2 = Asl,com/(b*d)*(fs2/fc) = 0.09267785
v = Asl,mid/(b*d)*(fsv/fc) = 0.17271781
and confined core properties:
 b = 190.00
 d = 527.00
 d' = 13.00
 fcc (5A.2, TBDY) = 20.00
 cc (5A.5, TBDY) = 0.002
 c = confinement factor = 1.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.27144246
 2 = Asl,com/(b*d)*(fs2/fc) = 0.12888635
 v = Asl,mid/(b*d)*(fsv/fc) = 0.24019729
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
 su (4.8) = 0.32821245
Mu = MRc (4.15) = 4.1999E+008
 u =   su (4.1) = 1.3683047E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
 u = 1.0987588E-005
Mu = 2.3955E+008
----
with full section properties:
 b = 600.00
 d = 557.00
 d' = 43.00
 v = 0.00132912
 N = 8883.864
 fc = 20.00
 co (5A.5, TBDY) = 0.002
 Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: cu = 0.00768077
 we (5.4c) = 0.01092426
 ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
 The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
 of the rectangular sections confinement, which is expressed by (5.4d).
 The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)

"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to   bi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813

Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

----

psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00

----

psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00

----

s = 100.00
fywe = 555.55
fce = 20.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00129669
sh1 = 0.0044814
ft1 = 373.4467
fy1 = 311.2056
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 311.2056
with Es1 = Es = 200000.00
y2 = 0.00129669
sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 311.2056
with Es2 = Es = 200000.00
yv = 0.00129669
shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 0.30
  suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
  with fsv = fs = 311.2056
  with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.03861577
2 = Asl,com/(b*d)*(fs2/fc) = 0.08132715
v = Asl,mid/(b*d)*(fsv/fc) = 0.07196575
and confined core properties:
  b = 540.00
  d = 527.00
  d' = 13.00
  fcc (5A.2, TBDY) = 20.00
  cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.0453489
  2 = Asl,com/(b*d)*(fs2/fc) = 0.09550753
  v = Asl,mid/(b*d)*(fsv/fc) = 0.08451386
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.16341054
Mu = MRc (4.14) = 2.3955E+008
 u = su (4.1) = 1.0987588E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 u = 1.3683047E-005
Mu = 4.1999E+008
----
with full section properties:
  b = 250.00
  d = 557.00
  d' = 43.00
  v = 0.0031899
   N = 8883.864
  fc = 20.00
  co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00768077
      we (5.4c) = 0.01092426
      ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
           is calculated as the area of core enclosed by the center lines of the perimeter hoops.
        Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and

is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.

AnoConf = 105733.333 is the unconfined core area which is equal to bi2/6 as defined at (A.2).

psh,min = Min(psh,x , psh,y) = 0.00482813

Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

----

psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00

----

psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00

----

s = 100.00
fywe = 555.55
fce = 20.00
From ((5.A5), TBDY): cc = 0.002
c = confinement factor = 1.00
y1 = 0.00129669
sh1 = 0.0044814
ft1 = 373.4467
fy1 = 311.2056
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 311.2056
with Es1 = Es = 200000.00
y2 = 0.00129669
sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 311.2056
with Es2 = Es = 200000.00
yv = 0.00129669
shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered

characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
   y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
    with fsv = fs = 311.2056
    with Esv = Es = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.19518516
  2 = Asl,com/(b*d)*(fs2/fc) = 0.09267785
  v = Asl,mid/(b*d)*(fsv/fc) = 0.17271781
and confined core properties:
  b = 190.00
  d = 527.00
  d' = 13.00
  fcc (5A.2, TBDY) = 20.00
   cc (5A.5, TBDY) = 0.002
     c = confinement factor = 1.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.27144246
  2 = Asl,com/(b*d)*(fs2/fc) = 0.12888635
  v = Asl,mid/(b*d)*(fsv/fc) = 0.24019729
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
 su (4.8) = 0.32821245
Mu = MRc (4.15) = 4.1999E+008
  u =   su (4.1) = 1.3683047E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.0987588E-005
Mu = 2.3955E+008
----
with full section properties:
  b = 600.00
  d = 557.00
  d' = 43.00
  v = 0.00132912
    N = 8883.864
  fc = 20.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00768077
      we (5.4c) = 0.01092426
      ase = Max((((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
         The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
         of the rectangular sections confinement, which is expressed by (5.4d).
         The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
         "Theoretical Stress-Strain Model for Confined Concrete."
         J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
         Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
                is calculated as the area of core enclosed by the center lines of the perimeter hoops.
         Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
                is calculated by reducing all the dimensions of the area Aconf,max by a length
                equal to half the clear spacing between hoops.
         AnoConf = 105733.333 is the unconfined core area which is equal to   bi2/6 as defined at (A.2).

11

psh,min = Min(psh,x , psh,y) = 0.00482813
Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
   Lstir (Length of stirrups along Y) = 1460.00
   Astir (stirrups area) = 78.53982
   Asec (section area) = 237500.00

----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
   Lstir (Length of stirrups along X) = 1460.00
   Astir (stirrups area) = 78.53982
   Asec (section area) = 237500.00

----
s = 100.00
fywe = 555.55
fce = 20.00
From ((5.A5), TBDY), TBDY: cc = 0.002
  c = confinement factor = 1.00
y1 = 0.00129669
sh1 = 0.0044814
ft1 = 373.4467
fy1 = 311.2056
su1 = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
  su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esu1_nominal = 0.08,
  For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
  characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
  with fs1 = fs = 311.2056
  with Es1 = Es = 200000.00
y2 = 0.00129669
sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
su2 = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/lb,min = 0.30
  su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esu2_nominal = 0.08,
  For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
  characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
  with fs2 = fs = 311.2056
  with Es2 = Es = 200000.00
yv = 0.00129669
shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
suv = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
  suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esuv_nominal = 0.08,
  considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
  For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
  characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
  with fsv = fs = 311.2056

with Esv = Es = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.03861577
    2 = Asl,com/(b*d)*(fs2/fc) = 0.08132715
    v = Asl,mid/(b*d)*(fsv/fc) = 0.07196575
and confined core properties:
  b = 540.00
  d = 527.00
  d' = 13.00
  fcc (5A.2, TBDY) = 20.00
   cc (5A.5, TBDY) = 0.002
      c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.0453489
    2 = Asl,com/(b*d)*(fs2/fc) = 0.09550753
    v = Asl,mid/(b*d)*(fsv/fc) = 0.08451386
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
 v < vs,y2 - LHS eq.(4.5) is satisfied
--->
  su (4.9) = 0.16341054
Mu = MRc (4.14) = 2.3955E+008
  u =   su (4.1) = 1.0987588E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 424229.688

Calculation of Shear Strength at edge 1, Vr1 = 424229.688
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 424229.688
  knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

     = 1 (normal-weight concrete)
  fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
     Mu = 47.14131
     Vu = 0.00016213
  d = 0.8*h = 480.00
  Nu = 8883.864
  Ag = 150000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 474724.809
  where:
  Vs1 = 335099.865 is calculated for section web, with:
    d = 480.00
    Av = 157079.633
    fy = 444.44
    s = 100.00
  Vs1 is multiplied by   Col1 = 1.00
    s/d = 0.20833333
  Vs2 = 139624.944 is calculated for section flange, with:
    d = 200.00
    Av = 157079.633
    fy = 444.44
    s = 100.00
  Vs2 is multiplied by   Col2 = 1.00
    s/d = 0.50
  Vf ((11-3)-(11.4), ACI 440) = 0.00
  From (11-11), ACI 440: Vs + Vf <= 356502.845

```
        bw = 250.00
----------------------------------------------------------------
-----------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 424229.688
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
   VCol0 = 424229.688
   knl = 1 (zero step-static loading)
----------------------------------------------------------------
NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+  f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
----------------------------------------------------------------
     = 1 (normal-weight concrete)
   fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
   M/Vd = 4.00
      Mu = 47.14134
      Vu = 0.00016213
   d = 0.8*h = 480.00
   Nu = 8883.864
   Ag = 150000.00
   From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 474724.809
   where:
   Vs1 = 335099.865 is calculated for section web, with:
      d = 480.00
      Av = 157079.633
      fy = 444.44
      s = 100.00
   Vs1 is multiplied by   Col1 = 1.00
      s/d = 0.20833333
   Vs2 = 139624.944 is calculated for section flange, with:
      d = 200.00
      Av = 157079.633
      fy = 444.44
      s = 100.00
   Vs2 is multiplied by   Col2 = 1.00
      s/d = 0.50
   Vf ((11-3)-(11.4), ACI 440) = 0.00
   From (11-11), ACI 440: Vs + Vf <= 356502.845
      bw = 250.00
--------------------------------------------------------------
--------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At local axis: 3


--------------------------------------------------------------


Start Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rclcs

Constant Properties
--------------------------------------------------------------
Knowledge Factor,    = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
###########################################################
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55
###########################################################
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
```

Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = 0.00016213
EDGE -B-
Shear Force, Vb = -0.00016213
BOTH EDGES
Axial Force, F = -8883.864
Longitudinal Reinforcement Area Distribution (in 2 divisions)
     -Tension: Aslt = 0.00
   -Compression: Aslc = 4121.77
Longitudinal Reinforcement Area Distribution (in 3 divisions)
     -Tension: Asl,ten = 1746.726
   -Compression: Asl,com = 829.3805
     -Middle: Asl,mid = 1545.664

Calculation of Shear Capacity ratio , Ve/Vr = 0.66001051
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 279996.052
with
Mpr1 = Max(Mu1+ , Mu1-) = 4.1999E+008
  Mu1+ = 4.1999E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
  Mu1- = 2.3955E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 4.1999E+008
  Mu2+ = 4.1999E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
  Mu2- = 2.3955E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 1.3683047E-005
Mu = 4.1999E+008
----
with full section properties:
  b = 250.00
  d = 557.00
  d' = 43.00
  ν = 0.0031899
    N = 8883.864
  fc = 20.00
   εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.00768077

The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00768077
  we (5.4c) = 0.01092426
   ase = Max((((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
      The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
      of the rectangular sections confinement, which is expressed by (5.4d).
      The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
      "Theoretical Stress-Strain Model for Confined Concrete."
      J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
      Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
            is calculated as the area of core enclosed by the center lines of the perimeter hoops.
      Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
            is calculated by reducing all the dimensions of the area Aconf,max by a length
            equal to half the clear spacing between hoops.
      AnoConf = 105733.333 is the unconfined core area which is equal to   bi2/6 as defined at (A.2).
   psh,min = Min(psh,x , psh,y) = 0.00482813
  Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
   ----
   psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
      Lstir (Length of stirrups along Y) = 1460.00
      Astir (stirrups area) = 78.53982
      Asec (section area) = 237500.00
   ----
   psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
      Lstir (Length of stirrups along X) = 1460.00
      Astir (stirrups area) = 78.53982
      Asec (section area) = 237500.00
   ----
      s = 100.00
      fywe = 555.55
      fce = 20.00
   From ((5.A5), TBDY), TBDY: cc = 0.002
      c = confinement factor = 1.00
  y1 = 0.00129669
  sh1 = 0.0044814
 ft1 = 373.4467
 fy1 = 311.2056
  su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
     su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and   y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
     with fs1 = fs = 311.2056
     with Es1 = Es = 200000.00
  y2 = 0.00129669
  sh2 = 0.0044814
 ft2 = 373.4467
 fy2 = 311.2056
  su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.30
     su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and   y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
     y1, ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
     with fs2 = fs = 311.2056
     with Es2 = Es = 200000.00
  yv = 0.00129669

shv = 0.0044814
    ftv = 373.4467
    fyv = 311.2056
     suv = 0.00512
       using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
       and also multiplied by the shear_factor according to 15.7.1.4, with
       Shear_factor = 1.00
       lo/lou,min = lb/ld = 0.30
        suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
       From table 5A.1, TBDY: esuv_nominal = 0.08,
       considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
       For calculation of esuv_nominal and   yv, shv,ftv,fyv, it is considered
       characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
        y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
        with fsv = fs = 311.2056
        with Esv = Es = 200000.00
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.19518516
     2 = Asl,com/(b*d)*(fs2/fc) = 0.09267785
     v = Asl,mid/(b*d)*(fsv/fc) = 0.17271781
and confined core properties:
   b = 190.00
   d = 527.00
   d' = 13.00
   fcc (5A.2, TBDY) = 20.00
    cc (5A.5, TBDY) = 0.002
       c = confinement factor = 1.00
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.27144246
     2 = Asl,com/(b*d)*(fs2/fc) = 0.12888635
     v = Asl,mid/(b*d)*(fsv/fc) = 0.24019729
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
 su (4.8) = 0.32821245
Mu = MRc (4.15) = 4.1999E+008
  u =   su (4.1) = 1.3683047E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.0987588E-005
Mu = 2.3955E+008
----
with full section properties:
   b = 600.00
   d = 557.00
   d' = 43.00
   v = 0.00132912
     N = 8883.864
   fc = 20.00
    co (5A.5, TBDY) = 0.002
   Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: cu = 0.00768077
       we (5.4c) = 0.01092426

ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783

The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
        is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
        is calculated by reducing all the dimensions of the area Aconf,max by a length
        equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to   bi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813

Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

----

psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
    Lstir (Length of stirrups along Y) = 1460.00
    Astir (stirrups area) = 78.53982
    Asec (section area) = 237500.00

----

psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
    Lstir (Length of stirrups along X) = 1460.00
    Astir (stirrups area) = 78.53982
    Asec (section area) = 237500.00

----

    s = 100.00
    fywe = 555.55
    fce = 20.00
From ((5.A5), TBDY), TBDY: cc = 0.002
    c = confinement factor = 1.00
y1 = 0.00129669
sh1 = 0.0044814
ft1 = 373.4467
fy1 = 311.2056
su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
    with fs1 = fs = 311.2056
    with Es1 = Es = 200000.00
y2 = 0.00129669
sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.30
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
    with fs2 = fs = 311.2056
    with Es2 = Es = 200000.00
yv = 0.00129669
shv = 0.0044814
ftv = 373.4467
fyv = 311.2056

suv = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
   suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esuv_nominal = 0.08,
  considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
  For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
  characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
   y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
   with fsv = fs = 311.2056
   with Esv = Es = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.03861577
  2 = Asl,com/(b*d)*(fs2/fc) = 0.08132715
  v = Asl,mid/(b*d)*(fsv/fc) = 0.07196575
and confined core properties:
  b = 540.00
  d = 527.00
  d' = 13.00
  fcc (5A.2, TBDY) = 20.00
   cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.0453489
  2 = Asl,com/(b*d)*(fs2/fc) = 0.09550753
  v = Asl,mid/(b*d)*(fsv/fc) = 0.08451386
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.16341054
Mu = MRc (4.14) = 2.3955E+008
 u = su (4.1) = 1.0987588E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 u = 1.3683047E-005
Mu = 4.1999E+008
----
with full section properties:
  b = 250.00
  d = 557.00
  d' = 43.00
  v = 0.0031899
   N = 8883.864
  fc = 20.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
   The Shear_factor is considered equal to 1 (pure moment strength)
   From (5.4b), TBDY: cu = 0.00768077
    we (5.4c) = 0.01092426
    ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
     The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
     of the rectangular sections confinement, which is expressed by (5.4d).
     The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
     "Theoretical Stress-Strain Model for Confined Concrete."

Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to   bi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 555.55
fce = 20.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00129669
sh1 = 0.0044814
ft1 = 373.4467
fy1 = 311.2056
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and   y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 311.2056
with Es1 = Es = 200000.00
y2 = 0.00129669
sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and   y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 311.2056
with Es2 = Es = 200000.00
yv = 0.00129669
shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
 y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
 with fsv = fs = 311.2056
 with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.19518516
2 = Asl,com/(b*d)*(fs2/fc) = 0.09267785
v = Asl,mid/(b*d)*(fsv/fc) = 0.17271781
and confined core properties:
  b = 190.00
  d = 527.00
  d' = 13.00
  fcc (5A.2, TBDY) = 20.00
   cc (5A.5, TBDY) = 0.002
      c = confinement factor = 1.00
      1 = Asl,ten/(b*d)*(fs1/fc) = 0.27144246
      2 = Asl,com/(b*d)*(fs2/fc) = 0.12888635
      v = Asl,mid/(b*d)*(fsv/fc) = 0.24019729
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
 su (4.8) = 0.32821245
Mu = MRc (4.15) = 4.1999E+008
  u =   su (4.1) = 1.3683047E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.0987588E-005
Mu = 2.3955E+008
----
with full section properties:
  b = 600.00
  d = 557.00
  d' = 43.00
  v = 0.00132912
    N = 8883.864
  fc = 20.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00768077
      we (5.4c) = 0.01092426
      ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
          The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
          of the rectangular sections confinement, which is expressed by (5.4d).
          The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
          "Theoretical Stress-Strain Model for Confined Concrete."
          J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
          Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
                is calculated as the area of core enclosed by the center lines of the perimeter hoops.

Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to bi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

----

psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00

----

psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00

----

s = 100.00
fywe = 555.55
fce = 20.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00129669
sh1 = 0.0044814
ft1 = 373.4467
fy1 = 311.2056
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 311.2056
with Es1 = Es = 200000.00
y2 = 0.00129669
sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 311.2056
with Es2 = Es = 200000.00
yv = 0.00129669
shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY

For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
 y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
  with fsv = fs = 311.2056
  with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.03861577
2 = Asl,com/(b*d)*(fs2/fc) = 0.08132715
v = Asl,mid/(b*d)*(fsv/fc) = 0.07196575
and confined core properties:
 b = 540.00
 d = 527.00
 d' = 13.00
 fcc (5A.2, TBDY) = 20.00
  cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.0453489
  2 = Asl,com/(b*d)*(fs2/fc) = 0.09550753
  v = Asl,mid/(b*d)*(fsv/fc) = 0.08451386
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.16341054
Mu = MRc (4.14) = 2.3955E+008
 u =   su (4.1) = 1.0987588E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 424229.688

Calculation of Shear Strength at edge 1, Vr1 = 424229.688
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 424229.688
  knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

    = 1 (normal-weight concrete)
 fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
 M/Vd = 4.00
    Mu = 47.13723
    Vu = 0.00016213
 d = 0.8*h = 480.00
 Nu = 8883.864
 Ag = 150000.00
 From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 474724.809
 where:
 Vs1 = 139624.944 is calculated for section web, with:
   d = 200.00
   Av = 157079.633
   fy = 444.44
   s = 100.00
 Vs1 is multiplied by Col1 = 1.00
   s/d = 0.50
 Vs2 = 335099.865 is calculated for section flange, with:
   d = 480.00
   Av = 157079.633
   fy = 444.44
   s = 100.00

Vs2 is multiplied by   Col2 = 1.00
   s/d = 0.20833333
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 356502.845
   bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 424229.688
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
   VCol0 = 424229.688
   knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

   = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 4.00
   Mu = 47.13721
   Vu = 0.00016213
d = 0.8*h = 480.00
Nu = 8883.864
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 474724.809
where:
Vs1 = 139624.944 is calculated for section web, with:
   d = 200.00
   Av = 157079.633
   fy = 444.44
   s = 100.00
Vs1 is multiplied by   Col1 = 1.00
   s/d = 0.50
Vs2 = 335099.865 is calculated for section flange, with:
   d = 480.00
   Av = 157079.633
   fy = 444.44
   s = 100.00
Vs2 is multiplied by   Col2 = 1.00
   s/d = 0.20833333
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 356502.845
   bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column LC1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rclcs

Constant Properties

Knowledge Factor,   = 1.00
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00

Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lb/ld = 0.30
No FRP Wrapping

Stepwise Properties

Bending Moment, M = -315855.788
Shear Force, V2 = -4235.571
Shear Force, V3 = 145.8655
Axial Force, F = -9654.265
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
    -Compression: Aslc = 4121.77
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 1746.726
    -Compression: Asl,com = 829.3805
       -Middle: Asl,mid = 1545.664
Mean Diameter of Tension Reinforcement, DbL = 17.71429

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity   u,R =   * u = 0.00452905
 u =   y +   p = 0.00452905

 - Calculation of   y -
----
 y = (My*Ls/3)/EIeff = 0.00452905 ((4.29),Biskinis Phd))
 My = 2.6304E+008
 Ls = M/V (with Ls > 0.1*L and Ls < 2*L) = 2165.391
 From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 4.1921E+013
    factor = 0.30
      Ag = 237500.00
      fc' = 20.00
      N = 9654.265
   Ec*Ig = 1.3974E+014

Calculation of Yielding Moment My

Calculation of   y and My according to Annex 7   -
----
 y = Min(y_ten, y_com)
 y_ten = 3.6312890E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^ 2/3) = 248.9644
    d = 557.00
     y = 0.38455208
    A = 0.02987826
    B = 0.0192605
     with pt = 0.01254381
        pc = 0.00595605
        pv = 0.01109992
        N = 9654.265
        b = 250.00
        " = 0.07719928
   y_comp = 8.0241107E-006

with fc = 20.00
   Ec = 21019.039
    y = 0.38321062
   A = 0.02939738
   B = 0.01898202
    with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

 - Calculation of   p -

From table 10-8:   p = 0.00
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
  shear control ratio V_{yE}/V_{Col0E} = 0.66001051
  d = 557.00
  s = 0.00
   t = $A_v/(b_w*s)$ + $2*t_f/b_w*(f_{fe}/f_s)$ = $A_v*L_{stir}/(A_g*s)$ + $2*t_f/b_w*(f_{fe}/f_s)$ = 0.00
  Av = 78.53982, is the area of every stirrup
  Lstir = 1460.00, is the total Length of all stirrups parallel to loading (shear) direction
  The term $2*t_f/b_w*(f_{fe}/f_s)$ is implemented to account for FRP contribution
  where   f = $2*t_f/b_w$ is FRP ratio (EC8 - 3, A.4.4.3(6)) and f_{fe}/f_s normalises   f to steel strength
  All these variables have already been given in Shear control ratio calculation.
   NUD = 9654.265
   Ag = 237500.00
   f'cE = 20.00
   fytE = fylE = 0.00
pl = Area_Tot_Long_Rein/(b*d) = 0.02959978
  b = 250.00
  d = 557.00
   f'cE = 20.00

End Of Calculation of Chord Rotation Capacity for element: column LC1 of floor 1
At local axis: 2
Integration Section: (a)

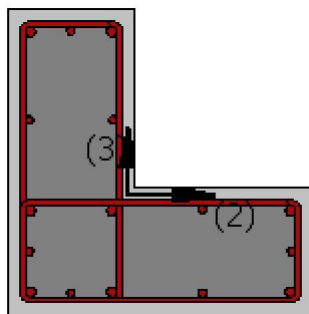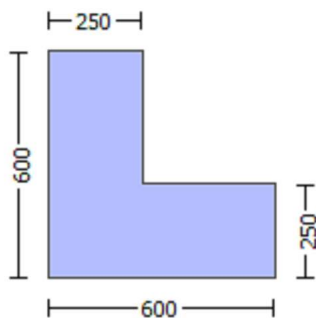
Calculation No. 3

column C1, Floor 1

Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (3)

Start Of Calculation of Shear Capacity for element: column LC1 of floor 1
At local axis: 3
Integration Section: (a)
Section Type: rclcs

Constant Properties

Knowledge Factor, = 1.00
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of y for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE41-17).
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.44
###
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min =lb/ld = 0.30
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -315855.788
Shear Force, Va = 145.8655
EDGE -B-
Bending Moment, Mb = -120136.835
Shear Force, Vb = -145.8655
BOTH EDGES
Axial Force, F = -9654.265
Longitudinal Reinforcement Area Distribution (in 2 divisions)
     -Tension: Aslt = 0.00
     -Compression: Aslc = 4121.77
Longitudinal Reinforcement Area Distribution (in 3 divisions)
     -Tension: Asl,ten = 1746.726

-Compression: Asl,com = 829.3805
              -Middle: Asl,mid = 1545.664
Mean Diameter of Tension Reinforcement, DbL,ten = 17.71429

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR =   *Vn = 379610.938
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 379610.938
   VCol = 379610.938
   knl = 1.00
       displacement_ductility_demand = 0.01041911

NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+   f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

    = 1 (normal-weight concrete)
   fc' = 16.00, but fc^0.5 < = 8.3 MPa (22.5.3.1, ACI 318-14)
   M/Vd = 4.00
       Mu = 315855.788
       Vu = 145.8655
   d = 0.8*h = 480.00
   Nu = 9654.265
   Ag = 150000.00
   From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 427256.601
   where:
   Vs1 = 301592.895 is calculated for section web, with:
       d = 480.00
       Av = 157079.633
       fy = 400.00
       s = 100.00
   Vs1 is multiplied by   Col1 = 1.00
       s/d = 0.20833333
   Vs2 = 125663.706 is calculated for section flange, with:
       d = 200.00
       Av = 157079.633
       fy = 400.00
       s = 100.00
   Vs2 is multiplied by   Col2 = 1.00
       s/d = 0.50
   Vf ((11-3)-(11.4), ACI 440) = 0.00
   From (11-11), ACI 440: Vs + Vf < = 318865.838
       bw = 250.00

----
displacement_ductility_demand is calculated as   / y

 - Calculation of   / y for END A -
 for rotation axis 2 and integ. section (a)

From analysis, chord rotation   = 4.7188645E-005
  y = (My*Ls/3)/EIeff = 0.00452905 ((4.29),Biskinis Phd))
   My = 2.6304E+008
   Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 2165.391
   From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 4.1921E+013
       factor = 0.30
          Ag = 237500.00
          fc' = 20.00
          N = 9654.265
       Ec*Ig = 1.3974E+014

Calculation of Yielding Moment My

Calculation of   y and My according to Annex 7   -

```
-----------------------------------------------------------
  y = Min(  y_ten,   y_com)
  y_ten = 3.6312890E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 248.9644
    d = 557.00
     y = 0.38455208
    A = 0.02987826
    B = 0.0192605
    with pt = 0.01254381
       pc = 0.00595605
       pv = 0.01109992
       N = 9654.265
       b = 250.00
       " = 0.07719928
  y_comp = 8.0241107E-006
 with fc = 20.00
    Ec = 21019.039
     y = 0.38321062
    A = 0.02939738
    B = 0.01898202
    with Es = 200000.00
-----------------------------------------------------------
-----------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
-----------------------------------------------------------
End Of Calculation of Shear Capacity for element: column LC1 of floor 1
At local axis: 3
Integration Section: (a)


-----------------------------------------------------------
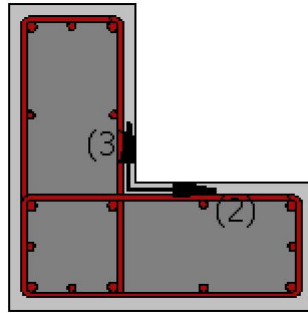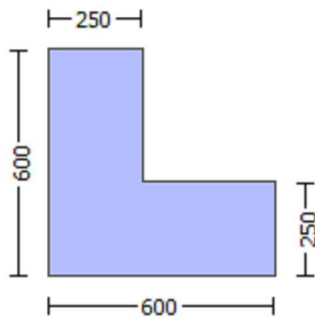```

## Calculation No. 4

column C1, Floor 1

Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity ( u)

Edge: Start

Local Axis: (3)

Start Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rclcs

Constant Properties
-------------------------------------------------------------
Knowledge Factor,    = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
############################################################
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55
############################################################
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
No FRP Wrapping
-------------------------------------------------------------

Stepwise Properties
-------------------------------------------------------------
At local axis: 3
EDGE -A-
Shear Force, Va = 0.00016213
EDGE -B-
Shear Force, Vb = -0.00016213
BOTH EDGES
Axial Force, F = -8883.864
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
   -Compression: Aslc = 4121.77
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 1746.726
   -Compression: Asl,com = 829.3805
      -Middle: Asl,mid = 1545.664
-------------------------------------------------------------

---------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr  =  0.66001051
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 279996.052
with
Mpr1 =  Max(Mu1+ , Mu1-) = 4.1999E+008
   Mu1+ = 4.1999E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
   Mu1- = 2.3955E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
Mpr2 =  Max(Mu2+ , Mu2-) = 4.1999E+008
   Mu2+ = 4.1999E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
   Mu2- = 2.3955E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination


---------------------------------------------------------------------------
Calculation of Mu1+
---------------------------------------------------------------------------

---------------------------------------------------------------------------
Calculation of ultimate curvature   $\phi$u according to 4.1, Biskinis/Fardis 2013:
   $\phi$u = 1.3683047E-005
Mu = 4.1999E+008
---------------------------------------------------------------------------
with full section properties:
   b = 250.00
   d = 557.00
   d' = 43.00
   v = 0.0031899
     N = 8883.864
   fc = 20.00
    $\epsilon$co (5A.5, TBDY) = 0.002
   Final value of  $\epsilon$cu:  $\epsilon$cu* = shear_factor * Max( $\epsilon$cu, $\epsilon$cc) = 0.00768077
      The Shear_factor is considered equal to 1 (pure moment strength)
      From (5.4b), TBDY: $\epsilon$cu = 0.00768077
        $\omega$we (5.4c) = 0.01092426
        $\alpha$se = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
           The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
           of the rectangular sections confinement, which is expressed by (5.4d).
           The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
           "Theoretical Stress-Strain Model for Confined Concrete."
           J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
           Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
                 is calculated as the area of core enclosed by the center lines of the perimeter hoops.
           Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
                 is calculated by reducing all the dimensions of the area Aconf,max by a length
                 equal to half the clear spacing between hoops.
           AnoConf = 105733.333 is the unconfined core area which is equal to $\Sigma$bi2/6 as defined at (A.2).
        $\rho$sh,min = Min($\rho$sh,x , $\rho$sh,y) = 0.00482813
      Expression ((5.4d), TBDY) for $\rho$sh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
        ---------------------------------------------------------------
         $\rho$sh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
           Lstir (Length of stirrups along Y) = 1460.00
           Astir (stirrups area) = 78.53982
           Asec (section area) = 237500.00
        ---------------------------------------------------------------
         $\rho$sh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
           Lstir (Length of stirrups along X) = 1460.00
           Astir (stirrups area) = 78.53982
           Asec (section area) = 237500.00
        ---------------------------------------------------------------
           s = 100.00
         fywe = 555.55

fce  = 20.00
    From ((5.A.5), TBDY), TBDY:  cc = 0.002
        c  = confinement factor = 1.00
   y1 = 0.00129669
  sh1 = 0.0044814
 ft1 = 373.4467
 fy1 = 311.2056
  su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
     su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
     with fs1 = fs = 311.2056
     with Es1 = Es = 200000.00
   y2 = 0.00129669
  sh2 = 0.0044814
 ft2 = 373.4467
 fy2 = 311.2056
  su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.30
     su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
     with fs2 = fs = 311.2056
     with Es2 = Es = 200000.00
   yv = 0.00129669
  shv = 0.0044814
 ftv = 373.4467
 fyv = 311.2056
  suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
     suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and  yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
     with fsv = fs = 311.2056
     with Esv = Es = 200000.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.19518516
   2 = Asl,com/(b*d)*(fs2/fc) = 0.09267785
   v = Asl,mid/(b*d)*(fsv/fc) = 0.17271781
and confined core properties:
  b = 190.00
  d = 527.00
  d' = 13.00
  fcc (5A.2, TBDY) = 20.00
   cc (5A.5, TBDY) = 0.002
      c  = confinement factor = 1.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.27144246
   2 = Asl,com/(b*d)*(fs2/fc) = 0.12888635
   v = Asl,mid/(b*d)*(fsv/fc) = 0.24019729
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)

--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
 su (4.8) = 0.32821245
Mu = MRc (4.15) = 4.1999E+008
  u =   su (4.1) = 1.3683047E-005
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
----------------------------------------------------------------------
----------------------------------------------------------------------
----------------------------------------------------------------------
Calculation of Mu1-
----------------------------------------------------------------------

----------------------------------------------------------------------
Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.0987588E-005
Mu = 2.3955E+008
----------------------------------------------------------------------
with full section properties:
  b = 600.00
  d = 557.00
  d' = 43.00
  v = 0.00132912
    N = 8883.864
  fc = 20.00
   co (5A.5, TBDY) = 0.002
  Final value of  cu:  cu* = shear_factor * Max( cu, cc) = 0.00768077
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY:  cu = 0.00768077
      we (5.4c) = 0.01092426
      ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
              is calculated as the area of core enclosed by the center lines of the perimeter hoops.
        Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
              is calculated by reducing all the dimensions of the area Aconf,max by a length
              equal to half the clear spacing between hoops.
        AnoConf = 105733.333 is the unconfined core area which is equal to   bi2/6 as defined at (A.2).
      psh,min = Min(psh,x , psh,y) = 0.00482813
    Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
      -------------------------------------------------------------------
        psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
          Lstir (Length of stirrups along Y) = 1460.00
          Astir (stirrups area) = 78.53982
          Asec (section area) = 237500.00
      -------------------------------------------------------------------
        psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
          Lstir (Length of stirrups along X) = 1460.00
          Astir (stirrups area) = 78.53982
          Asec (section area) = 237500.00
      -------------------------------------------------------------------
          s = 100.00
        fywe = 555.55
        fce  = 20.00
    From ((5.A5), TBDY), TBDY:  cc = 0.002
        c  = confinement factor = 1.00

y1 = 0.00129669
sh1 = 0.0044814
ft1 = 373.4467
fy1 = 311.2056
su1 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.30
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esu1_nominal = 0.08,
   For calculation of esu1_nominal and   y1, sh1,ft1,fy1, it is considered
   characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
    with fs1 = fs = 311.2056
    with Es1 = Es = 200000.00
y2 = 0.00129669
sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
su2 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/lb,min = 0.30
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esu2_nominal = 0.08,
   For calculation of esu2_nominal and   y2, sh2,ft2,fy2, it is considered
   characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
    with fs2 = fs = 311.2056
    with Es2 = Es = 200000.00
yv = 0.00129669
shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
suv = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.30
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esuv_nominal = 0.08,
   considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
   For calculation of esuv_nominal and   yv, shv,ftv,fyv, it is considered
   characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
    with fsv = fs = 311.2056
    with Esv = Es = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.03861577
  2 = Asl,com/(b*d)*(fs2/fc) = 0.08132715
  v = Asl,mid/(b*d)*(fsv/fc) = 0.07196575
and confined core properties:
  b = 540.00
  d = 527.00
  d' = 13.00
  fcc (5A.2, TBDY) = 20.00
  cc (5A.5, TBDY) = 0.002
    c  = confinement factor = 1.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.0453489
  2 = Asl,com/(b*d)*(fs2/fc) = 0.09550753
  v = Asl,mid/(b*d)*(fsv/fc) = 0.08451386
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->

su (4.9) = 0.16341054
Mu = MRc (4.14) = 2.3955E+008
 u =   su (4.1) = 1.0987588E-005
--------------------------------------------------------------

Calculation of ratio lb/ld
--------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
----------------------------------------------------------------------
----------------------------------------------------------------------
----------------------------------------------------------------------
Calculation of Mu2+
----------------------------------------------------------------------

----------------------------------------------------------------------
Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
 u = 1.3683047E-005
Mu = 4.1999E+008
----------------------------------------------------------------------
with full section properties:
  b = 250.00
  d = 557.00
  d' = 43.00
  v = 0.0031899
    N = 8883.864
  fc = 20.00
   co (5A.5, TBDY) = 0.002
  Final value of   cu:  cu* = shear_factor * Max( cu, cc) = 0.00768077
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY:  cu = 0.00768077
      we (5.4c) = 0.01092426
      ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
          The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
          of the rectangular sections confinement, which is expressed by (5.4d).
          The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
          "Theoretical Stress-Strain Model for Confined Concrete."
          J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
          Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
                is calculated as the area of core enclosed by the center lines of the perimeter hoops.
          Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
                is calculated by reducing all the dimensions of the area Aconf,max by a length
                equal to half the clear spacing between hoops.
          AnoConf = 105733.333 is the unconfined core area which is equal to   bi2/6 as defined at (A.2).
      psh,min = Min(psh,x , psh,y) = 0.00482813
    Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
      ----------------------------------------------------------------------
      psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
        Lstir (Length of stirrups along Y) = 1460.00
        Astir (stirrups area) = 78.53982
        Asec (section area) = 237500.00
      ----------------------------------------------------------------------
      psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
        Lstir (Length of stirrups along X) = 1460.00
        Astir (stirrups area) = 78.53982
        Asec (section area) = 237500.00
      ----------------------------------------------------------------------
        s = 100.00
        fywe = 555.55
        fce = 20.00
      From ((5.A5), TBDY), TBDY:  cc = 0.002
          c = confinement factor = 1.00
   y1 = 0.00129669
   sh1 = 0.0044814
  ft1 = 373.4467
  fy1 = 311.2056
   su1 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
  su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
  with fs1 = fs = 311.2056
  with Es1 = Es = 200000.00
 y2 = 0.00129669
 sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
 su2 = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/lb,min = 0.30
   su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esu2_nominal = 0.08,
  For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
  characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
   y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
   with fs2 = fs = 311.2056
   with Es2 = Es = 200000.00
 yv = 0.00129669
 shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
 suv = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
   suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esuv_nominal = 0.08,
  considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
  For calculation of esuv_nominal and  yv, shv,ftv,fyv, it is considered
  characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
   y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
   with fsv = fs = 311.2056
   with Esv = Es = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.19518516
  2 = Asl,com/(b*d)*(fs2/fc) = 0.09267785
  v = Asl,mid/(b*d)*(fsv/fc) = 0.17271781
and confined core properties:
 b = 190.00
 d = 527.00
 d' = 13.00
 fcc (5A.2, TBDY) = 20.00
  cc (5A.5, TBDY) = 0.002
    c  = confinement factor = 1.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.27144246
  2 = Asl,com/(b*d)*(fs2/fc) = 0.12888635
  v = Asl,mid/(b*d)*(fsv/fc) = 0.24019729
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
 su (4.8) = 0.32821245
Mu = MRc (4.15) = 4.1999E+008
 u =   su (4.1) = 1.3683047E-005

-----------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
--------------------------------------------------------------------------
--------------------------------------------------------------------------
--------------------------------------------------------------------------
Calculation of Mu2-
--------------------------------------------------------------------------


--------------------------------------------------------------------------
Calculation of ultimate curvature   $\varphi_u$ according to 4.1, Biskinis/Fardis 2013:
  $\varphi_u$ = 1.0987588E-005
Mu = 2.3955E+008
--------------------------------------------------------------------------
with full section properties:
  b = 600.00
  d = 557.00
  d' = 43.00
  v = 0.00132912
    N = 8883.864
  fc = 20.00
   $\varepsilon_{co}$ (5A.5, TBDY) = 0.002
  Final value of  $\varepsilon_{cu}$:  $\varepsilon_{cu}$* = shear_factor * Max( $\varepsilon_{cu}$, $\varepsilon_{cc}$) = 0.00768077
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: $\varepsilon_{cu}$ = 0.00768077
      $\omega_{we}$ (5.4c) = 0.01092426
      $a_{se}$ = Max((($A_{conf,max}$-AnoConf)/$A_{conf,max}$)*($A_{conf,min}$/$A_{conf,max}$),0) = 0.27151783
        The definitions of AnoConf, $A_{conf,min}$ and $A_{conf,max}$ are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        $A_{conf,max}$ = 169100.00 is the confined core area at levels of member with hoops and
              is calculated as the area of core enclosed by the center lines of the perimeter hoops.
        $A_{conf,min}$ = 122525.00 is the confined core area at midway between the levels of hoops and
              is calculated by reducing all the dimensions of the area $A_{conf,max}$ by a length
              equal to half the clear spacing between hoops.
        AnoConf = 105733.333 is the unconfined core area which is equal to  $b_i2/6$ as defined at (A.2).
      $\rho_{sh,min}$ = Min($\rho_{sh,x}$ , $\rho_{sh,y}$) = 0.00482813
    Expression ((5.4d), TBDY) for $\rho_{sh,min}$ has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
      ------------------------------------------------------------------
      $\rho_{sh,x}$ ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
        Lstir (Length of stirrups along Y) = 1460.00
        Astir (stirrups area) = 78.53982
        Asec (section area) = 237500.00
      ------------------------------------------------------------------
      $\rho_{sh,y}$ ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
        Lstir (Length of stirrups along X) = 1460.00
        Astir (stirrups area) = 78.53982
        Asec (section area) = 237500.00
      ------------------------------------------------------------------
        s = 100.00
      fywe = 555.55
      fce = 20.00
    From ((5.A5), TBDY), TBDY: $\varepsilon_{cc}$ = 0.002
        $\alpha_c$ = confinement factor = 1.00
  $\varepsilon_{y1}$ = 0.00129669
  $\varepsilon_{sh1}$ = 0.0044814
  ft1 = 373.4467
  fy1 = 311.2056
  $\varepsilon_{su1}$ = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00

lo/lou,min = lb/ld = 0.30
  su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
  with fs1 = fs = 311.2056
  with Es1 = Es = 200000.00
 y2 = 0.00129669
 sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
 su2 = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/lb,min = 0.30
  su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
  with fs2 = fs = 311.2056
  with Es2 = Es = 200000.00
 yv = 0.00129669
 shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
 suv = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
  suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and  yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
  with fsv = fs = 311.2056
  with Esv = Es = 200000.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.03861577
 2 = Asl,com/(b*d)*(fs2/fc) = 0.08132715
 v = Asl,mid/(b*d)*(fsv/fc) = 0.07196575
and confined core properties:
 b = 540.00
 d = 527.00
 d' = 13.00
 fcc (5A.2, TBDY) = 20.00
  cc (5A.5, TBDY) = 0.002
   c = confinement factor = 1.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.0453489
  2 = Asl,com/(b*d)*(fs2/fc) = 0.09550753
  v = Asl,mid/(b*d)*(fsv/fc) = 0.08451386
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.16341054
Mu = MRc (4.14) = 2.3955E+008
 u =   su (4.1) = 1.0987588E-005
------------------------------------------------------------
Calculation of ratio lb/ld
------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30

```
----------------------------------------------------------------------
----------------------------------------------------------------------
----------------------------------------------------------------------
----------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 424229.688
----------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 424229.688
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
   VCol0 = 424229.688
   knl = 1 (zero step-static loading)
   -------------------------------------------------------------
NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+  f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
   -------------------------------------------------------------
      = 1 (normal-weight concrete)
   fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
   M/Vd = 4.00
      Mu = 47.14131
      Vu = 0.00016213
   d = 0.8*h = 480.00
   Nu = 8883.864
   Ag = 150000.00
   From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 474724.809
   where:
   Vs1 = 335099.865 is calculated for section web, with:
      d = 480.00
      Av = 157079.633
      fy = 444.44
      s = 100.00
   Vs1 is multiplied by   Col1 = 1.00
      s/d = 0.20833333
   Vs2 = 139624.944 is calculated for section flange, with:
      d = 200.00
      Av = 157079.633
      fy = 444.44
      s = 100.00
   Vs2 is multiplied by   Col2 = 1.00
      s/d = 0.50
   Vf ((11-3)-(11.4), ACI 440) = 0.00
   From (11-11), ACI 440: Vs + Vf <= 356502.845
      bw = 250.00
   -----------------------------------------------------------
----------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 424229.688
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
   VCol0 = 424229.688
   knl = 1 (zero step-static loading)
   -------------------------------------------------------------
NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+  f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
   -------------------------------------------------------------
      = 1 (normal-weight concrete)
   fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
   M/Vd = 4.00
      Mu = 47.14134
      Vu = 0.00016213
   d = 0.8*h = 480.00
   Nu = 8883.864
   Ag = 150000.00
   From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 474724.809
   where:
   Vs1 = 335099.865 is calculated for section web, with:
      d = 480.00
      Av = 157079.633
      fy = 444.44
      s = 100.00
   Vs1 is multiplied by   Col1 = 1.00
```

s/d = 0.20833333
    Vs2 = 139624.944 is calculated for section flange, with:
        d = 200.00
        Av = 157079.633
        fy = 444.44
        s = 100.00
    Vs2 is multiplied by   Col2 = 1.00
        s/d = 0.50
    Vf ((11-3)-(11.4), ACI 440) = 0.00
    From (11-11), ACI 440: Vs + Vf < = 356502.845
        bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rclcs

Constant Properties

Knowledge Factor,   = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55
###
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = 0.00016213
EDGE -B-
Shear Force, Vb = -0.00016213
BOTH EDGES
Axial Force, F = -8883.864
Longitudinal Reinforcement Area Distribution (in 2 divisions)
     -Tension: Aslt = 0.00
   -Compression: Aslc = 4121.77
Longitudinal Reinforcement Area Distribution (in 3 divisions)

```
        -Tension: Asl,ten = 1746.726
     -Compression: Asl,com = 829.3805
         -Middle: Asl,mid = 1545.664
------------------------------------------------------------
------------------------------------------------------------


Calculation of Shear Capacity ratio , Ve/Vr  =  0.66001051
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 279996.052
with
Mpr1 =  Max(Mu1+ , Mu1-) = 4.1999E+008
   Mu1+ = 4.1999E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
   Mu1- = 2.3955E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
Mpr2 =  Max(Mu2+ , Mu2-) = 4.1999E+008
   Mu2+ = 4.1999E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
   Mu2- = 2.3955E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination


----------------------------------------------------------------------------
Calculation of Mu1+
----------------------------------------------------------------------------


----------------------------------------------------------------------------
Calculation of ultimate curvature   φu according to 4.1, Biskinis/Fardis 2013:
  φu = 1.3683047E-005
Mu = 4.1999E+008
----------------------------------------------------------------------------
with full section properties:
  b = 250.00
  d = 557.00
  d' = 43.00
  v = 0.0031899
     N = 8883.864
  fc = 20.00
   εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.00768077
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: εcu = 0.00768077
       ωwe (5.4c) = 0.01092426
       αse = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
          The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
          of the rectangular sections confinement, which is expressed by (5.4d).
          The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
          "Theoretical Stress-Strain Model for Confined Concrete."
          J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
          Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
                  is calculated as the area of core enclosed by the center lines of the perimeter hoops.
          Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
                  is calculated by reducing all the dimensions of the area Aconf,max by a length
                  equal to half the clear spacing between hoops.
          AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
       ρsh,min = Min(ρsh,x , ρsh,y) = 0.00482813
     Expression ((5.4d), TBDY) for ρsh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
       ----------------------------------------------------------------
       ρsh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
          Lstir (Length of stirrups along Y) = 1460.00
          Astir (stirrups area) = 78.53982
          Asec (section area) = 237500.00
       ----------------------------------------------------------------
       ρsh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
          Lstir (Length of stirrups along X) = 1460.00
          Astir (stirrups area) = 78.53982
```

Asec (section area) = 237500.00

----

      s = 100.00

     fywe = 555.55

     fce = 20.00

From ((5.A5), TBDY), TBDY: cc = 0.002

   c = confinement factor = 1.00

$y1$ = 0.00129669

$sh1$ = 0.0044814

$ft1$ = 373.4467

$fy1$ = 311.2056

$su1$ = 0.00512

  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

  and also multiplied by the shear_factor according to 15.7.1.4, with

  Shear_factor = 1.00

  $lo/lou,min = lb/ld$ = 0.30

   $su1 = 0.4*esu1\_nominal$ ((5.5), TBDY) = 0.032

  From table 5A.1, TBDY: esu1_nominal = 0.08,

  For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered

  characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

   $y1, sh1,ft1,fy1$, are also multiplied by $Min(1,1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE41-17.

   with fs1 = fs = 311.2056

   with Es1 = Es = 200000.00

$y2$ = 0.00129669

$sh2$ = 0.0044814

$ft2$ = 373.4467

$fy2$ = 311.2056

$su2$ = 0.00512

  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

  and also multiplied by the shear_factor according to 15.7.1.4, with

  Shear_factor = 1.00

  $lo/lou,min = lb/lb,min$ = 0.30

   $su2 = 0.4*esu2\_nominal$ ((5.5), TBDY) = 0.032

  From table 5A.1, TBDY: esu2_nominal = 0.08,

  For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered

  characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

   $y1, sh1,ft1,fy1$, are also multiplied by $Min(1,1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE41-17.

   with fs2 = fs = 311.2056

   with Es2 = Es = 200000.00

yv = 0.00129669

shv = 0.0044814

ftv = 373.4467

fyv = 311.2056

suv = 0.00512

  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

  and also multiplied by the shear_factor according to 15.7.1.4, with

  Shear_factor = 1.00

  $lo/lou,min = lb/ld$ = 0.30

   $suv = 0.4*esuv\_nominal$ ((5.5), TBDY) = 0.032

  From table 5A.1, TBDY: esuv_nominal = 0.08,

  considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY

  For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered

  characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

   $y1, sh1,ft1,fy1$, are also multiplied by $Min(1,1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE41-17.

   with fsv = fs = 311.2056

   with Esv = Es = 200000.00

  $1 = Asl,ten/(b*d)*(fs1/fc)$ = 0.19518516

  $2 = Asl,com/(b*d)*(fs2/fc)$ = 0.09267785

  $v = Asl,mid/(b*d)*(fsv/fc)$ = 0.17271781

and confined core properties:

 b = 190.00

 d = 527.00

 d' = 13.00

 fcc (5A.2, TBDY) = 20.00

  cc (5A.5, TBDY) = 0.002

   c = confinement factor = 1.00

  $1 = Asl,ten/(b*d)*(fs1/fc)$ = 0.27144246

2 = Asl,com/(b*d)*(fs2/fc) = 0.12888635
    v = Asl,mid/(b*d)*(fsv/fc) = 0.24019729
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
 su (4.8) = 0.32821245
Mu = MRc (4.15) = 4.1999E+008
  u =   su (4.1) = 1.3683047E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.0987588E-005
Mu = 2.3955E+008
----
with full section properties:
  b = 600.00
  d = 557.00
  d' = 43.00
  v = 0.00132912
    N = 8883.864
  fc = 20.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00768077
      we (5.4c) = 0.01092426
      ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
          The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
          of the rectangular sections confinement, which is expressed by (5.4d).
          The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
          "Theoretical Stress-Strain Model for Confined Concrete."
          J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
          Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
                  is calculated as the area of core enclosed by the center lines of the perimeter hoops.
          Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
                  is calculated by reducing all the dimensions of the area Aconf,max by a length
                  equal to half the clear spacing between hoops.
          AnoConf = 105733.333 is the unconfined core area which is equal to bi2/6 as defined at (A.2).
        psh,min = Min(psh,x , psh,y) = 0.00482813
    Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

        ----
        psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
          Lstir (Length of stirrups along Y) = 1460.00
          Astir (stirrups area) = 78.53982
          Asec (section area) = 237500.00

        ----
        psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
          Lstir (Length of stirrups along X) = 1460.00
          Astir (stirrups area) = 78.53982
          Asec (section area) = 237500.00

        ----
          s = 100.00

```
      fywe =  555.55
       fce  =  20.00
   From ((5.A5), TBDY), TBDY:  cc = 0.002
        c  = confinement factor = 1.00
  y1 = 0.00129669
  sh1 = 0.0044814
ft1 = 373.4467
fy1 = 311.2056
  su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
     su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
     with fs1 = fs = 311.2056
     with Es1 = Es = 200000.00
  y2 = 0.00129669
  sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
  su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.30
     su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
     with fs2 = fs = 311.2056
     with Es2 = Es = 200000.00
  yv = 0.00129669
  shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
  suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
     suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and  yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
     with fsv = fs = 311.2056
     with Esv = Es = 200000.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.03861577
   2 = Asl,com/(b*d)*(fs2/fc) = 0.08132715
   v = Asl,mid/(b*d)*(fsv/fc) = 0.07196575
and confined core properties:
  b = 540.00
  d = 527.00
  d' = 13.00
  fcc (5A.2, TBDY) = 20.00
   cc (5A.5, TBDY) = 0.002
     c  = confinement factor = 1.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.0453489
   2 = Asl,com/(b*d)*(fs2/fc) = 0.09550753
   v = Asl,mid/(b*d)*(fsv/fc) = 0.08451386
Case/Assumption: Unconfinesd full section - Steel rupture
```

' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.16341054
Mu = MRc (4.14) = 2.3955E+008
 u =   su (4.1) = 1.0987588E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.3683047E-005
Mu = 4.1999E+008
----
with full section properties:
  b = 250.00
  d = 557.00
  d' = 43.00
  v = 0.0031899
    N = 8883.864
  fc = 20.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00768077
      we (5.4c) = 0.01092426
      ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
                is calculated as the area of core enclosed by the center lines of the perimeter hoops.
        Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
                is calculated by reducing all the dimensions of the area Aconf,max by a length
                equal to half the clear spacing between hoops.
        AnoConf = 105733.333 is the unconfined core area which is equal to bi2/6 as defined at (A.2).
      psh,min = Min(psh,x , psh,y) = 0.00482813
    Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
        ----
        psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
          Lstir (Length of stirrups along Y) = 1460.00
          Astir (stirrups area) = 78.53982
          Asec (section area) = 237500.00
        ----
        psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
          Lstir (Length of stirrups along X) = 1460.00
          Astir (stirrups area) = 78.53982
          Asec (section area) = 237500.00
        ----
          s = 100.00
        fywe = 555.55
        fce = 20.00
    From ((5.A5), TBDY), TBDY: cc = 0.002
        c = confinement factor = 1.00
  y1 = 0.00129669

sh1 = 0.0044814
ft1 = 373.4467
fy1 = 311.2056
su1 = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
  su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esu1_nominal = 0.08,
  For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
  characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
  with fs1 = fs = 311.2056
  with Es1 = Es = 200000.00
y2 = 0.00129669
sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
su2 = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/lb,min = 0.30
  su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esu2_nominal = 0.08,
  For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
  characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
  with fs2 = fs = 311.2056
  with Es2 = Es = 200000.00
yv = 0.00129669
shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
suv = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
  suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esuv_nominal = 0.08,
  considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
  For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
  characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
  with fsv = fs = 311.2056
  with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.19518516
2 = Asl,com/(b*d)*(fs2/fc) = 0.09267785
v = Asl,mid/(b*d)*(fsv/fc) = 0.17271781
and confined core properties:
b = 190.00
d = 527.00
d' = 13.00
fcc (5A.2, TBDY) = 20.00
cc (5A.5, TBDY) = 0.002
  c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.27144246
2 = Asl,com/(b*d)*(fs2/fc) = 0.12888635
v = Asl,mid/(b*d)*(fsv/fc) = 0.24019729
Case/Assumption: Unconfinesd full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied

```
--->
 su (4.8) = 0.32821245
Mu = MRc (4.15) = 4.1999E+008
  u =   su (4.1) = 1.3683047E-005
----------------------------------------------------------

Calculation of ratio lb/ld
----------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
--------------------------------------------------------------------
--------------------------------------------------------------------
--------------------------------------------------------------------
Calculation of Mu2-
--------------------------------------------------------------------

--------------------------------------------------------------------
Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.0987588E-005
Mu = 2.3955E+008
--------------------------------------------------------------------
with full section properties:
  b = 600.00
  d = 557.00
  d' = 43.00
  v = 0.00132912
    N = 8883.864
  fc = 20.00
   co (5A.5, TBDY) = 0.002
  Final value of  cu:  cu* = shear_factor * Max( cu, cc) = 0.00768077
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY:  cu = 0.00768077
      we (5.4c) = 0.01092426
      ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
              is calculated as the area of core enclosed by the center lines of the perimeter hoops.
        Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
              is calculated by reducing all the dimensions of the area Aconf,max by a length
              equal to half the clear spacing between hoops.
        AnoConf = 105733.333 is the unconfined core area which is equal to  bi2/6 as defined at (A.2).
      psh,min = Min(psh,x , psh,y) = 0.00482813
    Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
      --------------------------------------------------------------------
      psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
        Lstir (Length of stirrups along Y) = 1460.00
        Astir (stirrups area) = 78.53982
        Asec (section area) = 237500.00
      --------------------------------------------------------------------
      psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
        Lstir (Length of stirrups along X) = 1460.00
        Astir (stirrups area) = 78.53982
        Asec (section area) = 237500.00
      --------------------------------------------------------------------
        s = 100.00
        fywe = 555.55
        fce = 20.00
     From ((5.A5), TBDY), TBDY:  cc = 0.002
        c = confinement factor = 1.00
   y1 = 0.00129669
   sh1 = 0.0044814
  ft1 = 373.4467
  fy1 = 311.2056
```

su1 = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
  su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esu1_nominal = 0.08,
  For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
  characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
  with fs1 = fs = 311.2056
  with Es1 = Es = 200000.00
y2 = 0.00129669
sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
su2 = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/lb,min = 0.30
  su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esu2_nominal = 0.08,
  For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
  characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
  with fs2 = fs = 311.2056
  with Es2 = Es = 200000.00
yv = 0.00129669
shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
suv = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
  suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esuv_nominal = 0.08,
  considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
  For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
  characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
  with fsv = fs = 311.2056
  with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.03861577
2 = Asl,com/(b*d)*(fs2/fc) = 0.08132715
v = Asl,mid/(b*d)*(fsv/fc) = 0.07196575
and confined core properties:
b = 540.00
d = 527.00
d' = 13.00
fcc (5A.2, TBDY) = 20.00
cc (5A.5, TBDY) = 0.002
  c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0453489
2 = Asl,com/(b*d)*(fs2/fc) = 0.09550753
v = Asl,mid/(b*d)*(fsv/fc) = 0.08451386
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.16341054
Mu = MRc (4.14) = 2.3955E+008
u =   su (4.1) = 1.0987588E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 424229.688

Calculation of Shear Strength at edge 1, Vr1 = 424229.688
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 424229.688
  knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

    = 1 (normal-weight concrete)
  fc' = 20.00, but fc^0.5 < = 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
    Mu = 47.13723
    Vu = 0.00016213
  d = 0.8*h = 480.00
  Nu = 8883.864
  Ag = 150000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 474724.809
  where:
  Vs1 = 139624.944 is calculated for section web, with:
    d = 200.00
    Av = 157079.633
    fy = 444.44
    s = 100.00
  Vs1 is multiplied by   Col1 = 1.00
    s/d = 0.50
  Vs2 = 335099.865 is calculated for section flange, with:
    d = 480.00
    Av = 157079.633
    fy = 444.44
    s = 100.00
  Vs2 is multiplied by   Col2 = 1.00
    s/d = 0.20833333
  Vf ((11-3)-(11.4), ACI 440) = 0.00
  From (11-11), ACI 440: Vs + Vf < = 356502.845
    bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 424229.688
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 424229.688
  knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

    = 1 (normal-weight concrete)
  fc' = 20.00, but fc^0.5 < = 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
    Mu = 47.13721
    Vu = 0.00016213
  d = 0.8*h = 480.00
  Nu = 8883.864
  Ag = 150000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 474724.809
  where:
  Vs1 = 139624.944 is calculated for section web, with:
    d = 200.00

Av = 157079.633
        fy = 444.44
        s = 100.00
    Vs1 is multiplied by   Col1 = 1.00
        s/d = 0.50
    Vs2 = 335099.865 is calculated for section flange, with:
        d = 480.00
        Av = 157079.633
        fy = 444.44
        s = 100.00
    Vs2 is multiplied by   Col2 = 1.00
        s/d = 0.20833333
    Vf ((11-3)-(11.4), ACI 440) = 0.00
    From (11-11), ACI 440: Vs + Vf <= 356502.845
        bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column LC1 of floor 1
At local axis: 3
Integration Section: (a)
Section Type: rclcs

Constant Properties

Knowledge Factor,   = 1.00
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lb/ld = 0.30
No FRP Wrapping

Stepwise Properties

Bending Moment, M = -1.2874E+007
Shear Force, V2 = -4235.571
Shear Force, V3 = 145.8655
Axial Force, F = -9654.265
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 4121.77
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1746.726
     -Compression: Asl,com = 829.3805
        -Middle: Asl,mid = 1545.664
Mean Diameter of Tension Reinforcement, DbL = 17.71429

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = ⋆ θu = 0.00635746
 θu = θy + θp = 0.00635746

 - Calculation of θy -

 θy = (My*Ls/3)/EIeff = 0.00635746 ((4.29),Biskinis Phd))
 My = 2.6304E+008
 Ls = M/V (with Ls > 0.1*L and Ls < 2*L) = 3039.576
 From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 4.1921E+013
    factor = 0.30
      Ag = 237500.00
      fc' = 20.00
      N = 9654.265
    Ec*Ig = 1.3974E+014

Calculation of Yielding Moment My

Calculation of φy and My according to Annex 7 -

 φy = Min(φy_ten, φy_com)
 φy_ten = 3.6312890E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 248.9644
    d = 557.00
     ξy = 0.38455208
    A = 0.02987826
    B = 0.0192605
     with pt = 0.01254381
        pc = 0.00595605
        pv = 0.01109992
        N = 9654.265
        b = 250.00
        " = 0.07719928
 φy_comp = 8.0241107E-006
 with fc = 20.00
    Ec = 21019.039
     ξy = 0.38321062
    A = 0.02939738
    B = 0.01898202
     with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

 - Calculation of θp -

From table 10-8: θp = 0.00
with:
 - Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
   shear control ratio VyE/VCol0E = 0.66001051
   d = 557.00
   s = 0.00
    ρt = Av/(bw*s) + 2*tf/bw*(ffe/fs) = Av*Lstir/(Ag*s) + 2*tf/bw*(ffe/fs) = 0.00
   Av = 78.53982, is the area of every stirrup
   Lstir = 1460.00, is the total Length of all stirrups parallel to loading (shear) direction
   The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
   where ρf = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises ρf to steel strength

All these variables have already been given in Shear control ratio calculation.
   NUD = 9654.265
   Ag = 237500.00
   f'cE = 20.00
   fytE = fylE = 0.00
pl = Area_Tot_Long_Rein/(b*d) = 0.02959978
   b = 250.00
   d = 557.00
   f'cE = 20.00

End Of Calculation of Chord Rotation Capacity for element: column LC1 of floor 1
At local axis: 3
Integration Section: (a)

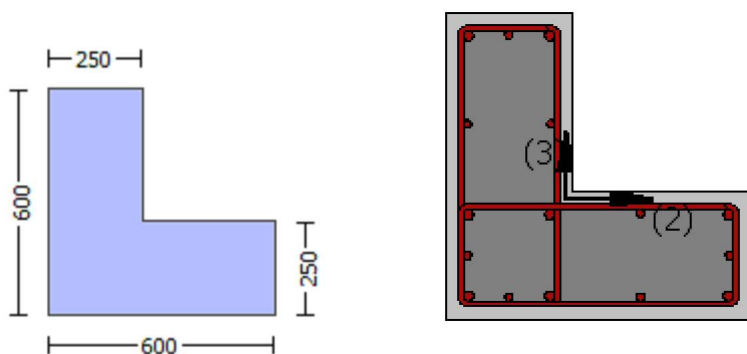# Calculation No. 5

column C1, Floor 1

Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (2)

Start Of Calculation of Shear Capacity for element: column LC1 of floor 1
At local axis: 2
Integration Section: (b)
Section Type: rclcs

Constant Properties

Knowledge Factor,   = 1.00
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00

Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of y for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE41-17).
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.44
###
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = lb/ld = 0.30
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -1.2874E+007
Shear Force, Va = -4235.571
EDGE -B-
Bending Moment, Mb = 163326.01
Shear Force, Vb = 4235.571
BOTH EDGES
Axial Force, F = -9654.265
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 4121.77
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1746.726
     -Compression: Asl,com = 829.3805
         -Middle: Asl,mid = 1545.664
Mean Diameter of Tension Reinforcement, DbL,ten = 17.71429

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR =   *Vn = 440356.038
Vn ((10.3), ASCE 41-17) = knl*VColO = 440356.038
   VCol = 440356.038
   knl = 1.00
     displacement_ductility_demand = 0.07563888

NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

    = 1 (normal-weight concrete)
  fc' = 16.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
     Mu = 163326.01
     Vu = 4235.571
   d = 0.8*h = 480.00
   Nu = 9654.265
   Ag = 150000.00
   From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 427256.601
   where:
   Vs1 = 125663.706 is calculated for section web, with:

```
    d = 200.00
    Av = 157079.633
    fy = 400.00
    s = 100.00
  Vs1 is multiplied by   Col1 = 1.00
    s/d = 0.50
  Vs2 = 301592.895 is calculated for section flange, with:
    d = 480.00
    Av = 157079.633
    fy = 400.00
    s = 100.00
  Vs2 is multiplied by   Col2 = 1.00
    s/d = 0.20833333
  Vf ((11-3)-(11.4), ACI 440) = 0.00
  From (11-11), ACI 440: Vs + Vf <= 318865.838
    bw = 250.00
-----------------------------------------------------------


-----------------------------------------------------------
displacement_ductility_demand is calculated as   / y

 - Calculation of   /  y for END B -
 for rotation axis 3 and integ. section (b)
-----------------------------------------------------------
From analysis, chord rotation    = 4.7460989E-005
 y = (My*Ls/3)/EIeff = 0.00062747 ((4.29),Biskinis Phd))
  My = 2.6304E+008
  Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 300.00
  From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 4.1921E+013
    factor = 0.30
      Ag = 237500.00
      fc' = 20.00
      N = 9654.265
    Ec*Ig = 1.3974E+014
-----------------------------------------------------------
-----------------------------------------------------------


Calculation of Yielding Moment My
-----------------------------------------------------------
Calculation of   y and My according to Annex 7   -
-----------------------------------------------------------
  y = Min(  y_ten,  y_com)
  y_ten = 3.6312890E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 248.9644
    d = 557.00
     y = 0.38455208
    A = 0.02987826
    B = 0.0192605
    with pt = 0.01254381
        pc = 0.00595605
        pv = 0.01109992
        N = 9654.265
        b = 250.00
        " = 0.07719928
  y_comp = 8.0241107E-006
 with fc = 20.00
    Ec = 21019.039
     y = 0.38321062
    A = 0.02939738
    B = 0.01898202
    with Es = 200000.00
-----------------------------------------------------------
-----------------------------------------------------------


Calculation of ratio lb/ld
-----------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
```
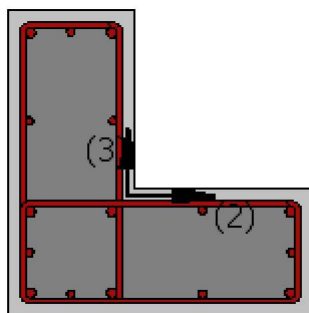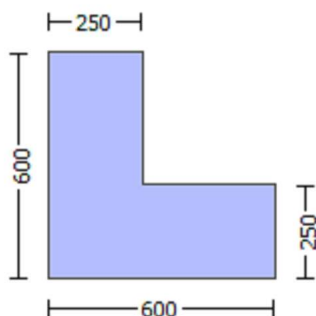

End Of Calculation of Shear Capacity for element: column LC1 of floor 1
At local axis: 2
Integration Section: (b)

Calculation No. 6

column C1, Floor 1

Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (u)

Edge: End

Local Axis: (2)

Start Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rclcs

Constant Properties

Knowledge Factor,   = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55
##
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00

Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = 0.00016213
EDGE -B-
Shear Force, Vb = -0.00016213
BOTH EDGES
Axial Force, F = -8883.864
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 4121.77
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1746.726
     -Compression: Asl,com = 829.3805
        -Middle: Asl,mid = 1545.664

Calculation of Shear Capacity ratio , Ve/Vr = 0.66001051
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 279996.052
with
Mpr1 = Max(Mu1+ , Mu1-) = 4.1999E+008
   Mu1+ = 4.1999E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
   Mu1- = 2.3955E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 4.1999E+008
   Mu2+ = 4.1999E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
   Mu2- = 2.3955E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.3683047E-005
Mu = 4.1999E+008
----
with full section properties:
  b = 250.00
  d = 557.00
  d' = 43.00
  v = 0.0031899
     N = 8883.864
  fc = 20.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: cu = 0.00768077

we (5.4c) = 0.01092426
ase = Max((((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
 The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
 of the rectangular sections confinement, which is expressed by (5.4d).
 The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
 "Theoretical Stress-Strain Model for Confined Concrete."
 J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
 Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
  is calculated as the area of core enclosed by the center lines of the perimeter hoops.
 Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
  is calculated by reducing all the dimensions of the area Aconf,max by a length
  equal to half the clear spacing between hoops.
 AnoConf = 105733.333 is the unconfined core area which is equal to   bi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

----

psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
 Lstir (Length of stirrups along Y) = 1460.00
 Astir (stirrups area) = 78.53982
 Asec (section area) = 237500.00

----

psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
 Lstir (Length of stirrups along X) = 1460.00
 Astir (stirrups area) = 78.53982
 Asec (section area) = 237500.00

----

 s = 100.00
 fywe = 555.55
 fce = 20.00
From ((5.A5), TBDY), TBDY: cc = 0.002
 c = confinement factor = 1.00
y1 = 0.00129669
sh1 = 0.0044814
ft1 = 373.4467
fy1 = 311.2056
su1 = 0.00512
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 lo/lou,min = lb/ld = 0.30
 su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
 From table 5A.1, TBDY: esu1_nominal = 0.08,
 For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
 characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
 y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
 with fs1 = fs = 311.2056
 with Es1 = Es = 200000.00
y2 = 0.00129669
sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
su2 = 0.00512
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 lo/lou,min = lb/lb,min = 0.30
 su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
 From table 5A.1, TBDY: esu2_nominal = 0.08,
 For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
 characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
 y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
 with fs2 = fs = 311.2056
 with Es2 = Es = 200000.00
yv = 0.00129669
shv = 0.0044814
ftv = 373.4467

fyv = 311.2056
  suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
     suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
     with fsv = fs = 311.2056
     with Esv = Es = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.19518516
  2 = Asl,com/(b*d)*(fs2/fc) = 0.09267785
  v = Asl,mid/(b*d)*(fsv/fc) = 0.17271781
and confined core properties:
  b = 190.00
  d = 527.00
  d' = 13.00
  fcc (5A.2, TBDY) = 20.00
   cc (5A.5, TBDY) = 0.002
     c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.27144246
    2 = Asl,com/(b*d)*(fs2/fc) = 0.12888635
    v = Asl,mid/(b*d)*(fsv/fc) = 0.24019729
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
 su (4.8) = 0.32821245
Mu = MRc (4.15) = 4.1999E+008
  u =   su (4.1) = 1.3683047E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.0987588E-005
Mu = 2.3955E+008
----
with full section properties:
  b = 600.00
  d = 557.00
  d' = 43.00
  v = 0.00132912
    N = 8883.864
  fc = 20.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00768077
      we (5.4c) = 0.01092426
      ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization

of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
    is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
    is calculated by reducing all the dimensions of the area Aconf,max by a length
    equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to   bi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
   Lstir (Length of stirrups along Y) = 1460.00
   Astir (stirrups area) = 78.53982
   Asec (section area) = 237500.00

----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
   Lstir (Length of stirrups along X) = 1460.00
   Astir (stirrups area) = 78.53982
   Asec (section area) = 237500.00

----
s = 100.00
fywe = 555.55
fce = 20.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00129669
sh1 = 0.0044814
ft1 = 373.4467
fy1 = 311.2056
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 311.2056
with Es1 = Es = 200000.00
y2 = 0.00129669
sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 311.2056
with Es2 = Es = 200000.00
yv = 0.00129669
shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/ld = 0.30

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY

For calculation of esuv_nominal and   yv, shv,ftv,fyv, it is considered

characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.

  with fsv = fs = 311.2056

  with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.03861577

2 = Asl,com/(b*d)*(fs2/fc) = 0.08132715

v = Asl,mid/(b*d)*(fsv/fc) = 0.07196575

and confined core properties:

  b = 540.00

  d = 527.00

  d' = 13.00

  fcc (5A.2, TBDY) = 20.00

   cc (5A.5, TBDY) = 0.002

      c = confinement factor = 1.00

  1 = Asl,ten/(b*d)*(fs1/fc) = 0.0453489

  2 = Asl,com/(b*d)*(fs2/fc) = 0.09550753

  v = Asl,mid/(b*d)*(fsv/fc) = 0.08451386

Case/Assumption: Unconfinesd full section - Steel rupture

 ' satisfies Eq. (4.3)

--->

v < vs,y2 - LHS eq.(4.5) is satisfied

--->

 su (4.9) = 0.16341054

Mu = MRc (4.14) = 2.3955E+008

 u =   su (4.1) = 1.0987588E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:

 u = 1.3683047E-005

Mu = 4.1999E+008

----

with full section properties:

  b = 250.00

  d = 557.00

  d' = 43.00

  v = 0.0031899

    N = 8883.864

  fc = 20.00

   co (5A.5, TBDY) = 0.002

  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077

    The Shear_factor is considered equal to 1 (pure moment strength)

    From (5.4b), TBDY: cu = 0.00768077

      we (5.4c) = 0.01092426

      ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783

          The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization

          of the rectangular sections confinement, which is expressed by (5.4d).

          The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)

          "Theoretical Stress-Strain Model for Confined Concrete."

          J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.

          Aconf,max = 169100.00 is the confined core area at levels of member with hoops and

is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to   bi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 555.55
fce = 20.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00129669
sh1 = 0.0044814
ft1 = 373.4467
fy1 = 311.2056
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 311.2056
with Es1 = Es = 200000.00
y2 = 0.00129669
sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 311.2056
with Es2 = Es = 200000.00
yv = 0.00129669
shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 311.2056
with Esv = Es = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.19518516
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.09267785
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.17271781
and confined core properties:
b = 190.00
d = 527.00
d' = 13.00
fcc (5A.2, TBDY) = 20.00
εcc (5A.5, TBDY) = 0.002
αc = confinement factor = 1.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.27144246
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.12888635
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.24019729
Case/Assumption: Unconfinesd full section - Steel rupture
' satisfies Eq. (4.3)
--->
εv < εvs,y2 - LHS eq.(4.5) is not satisfied
--->
εv < εvs,c - RHS eq.(4.5) is satisfied
--->
εsu (4.8) = 0.32821245
Mu = MRc (4.15) = 4.1999E+008
φu = φsu (4.1) = 1.3683047E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.0987588E-005
Mu = 2.3955E+008
----
with full section properties:
b = 600.00
d = 557.00
d' = 43.00
v = 0.00132912
N = 8883.864
fc = 20.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.00768077
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.00768077
ωwe (5.4c) = 0.01092426
αse = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length

equal to half the clear spacing between hoops.

AnoConf = 105733.333 is the unconfined core area which is equal to bi2/6 as defined at (A.2).

$psh,min = Min(psh,x , psh,y) = 0.00482813$

Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813$

Lstir (Length of stirrups along Y) = 1460.00

Astir (stirrups area) = 78.53982

Asec (section area) = 237500.00

$psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813$

Lstir (Length of stirrups along X) = 1460.00

Astir (stirrups area) = 78.53982

Asec (section area) = 237500.00

----

s = 100.00

fywe = 555.55

fce = 20.00

From ((5.A5), TBDY), TBDY: cc = 0.002

c = confinement factor = 1.00

y1 = 0.00129669

sh1 = 0.0044814

ft1 = 373.4467

fy1 = 311.2056

su1 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/ld = 0.30

$su1 = 0.4*esu1\_nominal ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered

characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.

with fs1 = fs = 311.2056

with Es1 = Es = 200000.00

y2 = 0.00129669

sh2 = 0.0044814

ft2 = 373.4467

fy2 = 311.2056

su2 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.30

$su2 = 0.4*esu2\_nominal ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered

characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.

with fs2 = fs = 311.2056

with Es2 = Es = 200000.00

yv = 0.00129669

shv = 0.0044814

ftv = 373.4467

fyv = 311.2056

suv = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/ld = 0.30

$suv = 0.4*esuv\_nominal ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY

For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered

characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
        with fsv = fs = 311.2056
        with Esv = Es = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.03861577
    2 = Asl,com/(b*d)*(fs2/fc) = 0.08132715
    v = Asl,mid/(b*d)*(fsv/fc) = 0.07196575
and confined core properties:
  b = 540.00
  d = 527.00
  d' = 13.00
  fcc (5A.2, TBDY) = 20.00
   cc (5A.5, TBDY) = 0.002
      c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.0453489
    2 = Asl,com/(b*d)*(fs2/fc) = 0.09550753
    v = Asl,mid/(b*d)*(fsv/fc) = 0.08451386
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.16341054
Mu = MRc (4.14) = 2.3955E+008
  u =   su (4.1) = 1.0987588E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 424229.688

Calculation of Shear Strength at edge 1, Vr1 = 424229.688
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 424229.688
  knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

    = 1 (normal-weight concrete)
  fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
     Mu = 47.14131
     Vu = 0.00016213
  d = 0.8*h = 480.00
  Nu = 8883.864
  Ag = 150000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 474724.809
  where:
  Vs1 = 335099.865 is calculated for section web, with:
    d = 480.00
    Av = 157079.633
    fy = 444.44
    s = 100.00
  Vs1 is multiplied by   Col1 = 1.00
    s/d = 0.20833333
  Vs2 = 139624.944 is calculated for section flange, with:
    d = 200.00
    Av = 157079.633
    fy = 444.44
    s = 100.00
  Vs2 is multiplied by   Col2 = 1.00
    s/d = 0.50

Vf ((11-3)-(11.4), ACI 440) = 0.00
  From (11-11), ACI 440: Vs + Vf <= 356502.845
    bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 424229.688
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 424229.688
  knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

    = 1 (normal-weight concrete)
  fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
    Mu = 47.14134
    Vu = 0.00016213
  d = 0.8*h = 480.00
  Nu = 8883.864
  Ag = 150000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 474724.809
  where:
  Vs1 = 335099.865 is calculated for section web, with:
    d = 480.00
    Av = 157079.633
    fy = 444.44
    s = 100.00
  Vs1 is multiplied by   Col1 = 1.00
    s/d = 0.20833333
  Vs2 = 139624.944 is calculated for section flange, with:
    d = 200.00
    Av = 157079.633
    fy = 444.44
    s = 100.00
  Vs2 is multiplied by   Col2 = 1.00
    s/d = 0.50
  Vf ((11-3)-(11.4), ACI 440) = 0.00
  From (11-11), ACI 440: Vs + Vf <= 356502.845
    bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rclcs

Constant Properties

Knowledge Factor,   = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55
###

Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = 0.00016213
EDGE -B-
Shear Force, Vb = -0.00016213
BOTH EDGES
Axial Force, F = -8883.864
Longitudinal Reinforcement Area Distribution (in 2 divisions)
     -Tension: Aslt = 0.00
   -Compression: Aslc = 4121.77
Longitudinal Reinforcement Area Distribution (in 3 divisions)
     -Tension: Asl,ten = 1746.726
   -Compression: Asl,com = 829.3805
     -Middle: Asl,mid = 1545.664

Calculation of Shear Capacity ratio , Ve/Vr = 0.66001051
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 279996.052
with
Mpr1 = Max(Mu1+ , Mu1-) = 4.1999E+008
   Mu1+ = 4.1999E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
   Mu1- = 2.3955E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 4.1999E+008
   Mu2+ = 4.1999E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
   Mu2- = 2.3955E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.3683047E-005
Mu = 4.1999E+008
----
with full section properties:
  b = 250.00
  d = 557.00
  d' = 43.00
  v = 0.0031899
    N = 8883.864
  fc = 20.00

co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
   The Shear_factor is considered equal to 1 (pure moment strength)
   From (5.4b), TBDY: cu = 0.00768077
    we (5.4c) = 0.01092426
    ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
      The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
      of the rectangular sections confinement, which is expressed by (5.4d).
      The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
      "Theoretical Stress-Strain Model for Confined Concrete."
      J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
      Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
        is calculated as the area of core enclosed by the center lines of the perimeter hoops.
      Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
        is calculated by reducing all the dimensions of the area Aconf,max by a length
        equal to half the clear spacing between hoops.
      AnoConf = 105733.333 is the unconfined core area which is equal to bi2/6 as defined at (A.2).
    psh,min = Min(psh,x , psh,y) = 0.00482813
   Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
    ----
    psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
      Lstir (Length of stirrups along Y) = 1460.00
      Astir (stirrups area) = 78.53982
      Asec (section area) = 237500.00
    ----
    psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
      Lstir (Length of stirrups along X) = 1460.00
      Astir (stirrups area) = 78.53982
      Asec (section area) = 237500.00
    ----
      s = 100.00
      fywe = 555.55
      fce = 20.00
   From ((5.A5), TBDY), TBDY: cc = 0.002
    c = confinement factor = 1.00
y1 = 0.00129669
sh1 = 0.0044814
ft1 = 373.4467
fy1 = 311.2056
su1 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.30
   su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esu1_nominal = 0.08,
   For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
   characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
   y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
   with fs1 = fs = 311.2056
   with Es1 = Es = 200000.00
y2 = 0.00129669
sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
su2 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/lb,min = 0.30
   su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esu2_nominal = 0.08,
   For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
   characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
   y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
   with fs2 = fs = 311.2056

with Es2 = Es = 200000.00
     yv = 0.00129669
     shv = 0.0044814
    ftv = 373.4467
    fyv = 311.2056
     suv = 0.00512
       using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
       and also multiplied by the shear_factor according to 15.7.1.4, with
       Shear_factor = 1.00
       lo/lou,min = lb/ld = 0.30
        suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
       From table 5A.1, TBDY: esuv_nominal = 0.08,
       considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
       For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
       characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
        y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
        with fsv = fs = 311.2056
        with Esv = Es = 200000.00
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.19518516
     2 = Asl,com/(b*d)*(fs2/fc) = 0.09267785
     v = Asl,mid/(b*d)*(fsv/fc) = 0.17271781
and confined core properties:
   b = 190.00
   d = 527.00
   d' = 13.00
   fcc (5A.2, TBDY) = 20.00
     cc (5A.5, TBDY) = 0.002
        c = confinement factor = 1.00
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.27144246
     2 = Asl,com/(b*d)*(fs2/fc) = 0.12888635
     v = Asl,mid/(b*d)*(fsv/fc) = 0.24019729
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
 su (4.8) = 0.32821245
Mu = MRc (4.15) = 4.1999E+008
  u =   su (4.1) = 1.3683047E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
   u = 1.0987588E-005
Mu = 2.3955E+008
----
with full section properties:
   b = 600.00
   d = 557.00
   d' = 43.00
   v = 0.00132912
      N = 8883.864
   fc = 20.00
    co (5A.5, TBDY) = 0.002
   Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
      The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: cu = 0.00768077
  we (5.4c) = 0.01092426
  ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
      The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
      of the rectangular sections confinement, which is expressed by (5.4d).
      The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
      "Theoretical Stress-Strain Model for Confined Concrete."
      J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
      Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
            is calculated as the area of core enclosed by the center lines of the perimeter hoops.
      Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
            is calculated by reducing all the dimensions of the area Aconf,max by a length
            equal to half the clear spacing between hoops.
      AnoConf = 105733.333 is the unconfined core area which is equal to   bi2/6 as defined at (A.2).
    psh,min = Min(psh,x , psh,y) = 0.00482813
  Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
      ----
      psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
        Lstir (Length of stirrups along Y) = 1460.00
        Astir (stirrups area) = 78.53982
        Asec (section area) = 237500.00
      ----
      psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
        Lstir (Length of stirrups along X) = 1460.00
        Astir (stirrups area) = 78.53982
        Asec (section area) = 237500.00
      ----
        s = 100.00
      fywe = 555.55
      fce = 20.00
    From ((5.A5), TBDY): cc = 0.002
        c = confinement factor = 1.00
  y1 = 0.00129669
  sh1 = 0.0044814
 ft1 = 373.4467
 fy1 = 311.2056
  su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and   y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
    with fs1 = fs = 311.2056
    with Es1 = Es = 200000.00
  y2 = 0.00129669
  sh2 = 0.0044814
 ft2 = 373.4467
 fy2 = 311.2056
  su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.30
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and   y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
    with fs2 = fs = 311.2056
    with Es2 = Es = 200000.00
  yv = 0.00129669
  shv = 0.0044814

ftv = 373.4467
fyv = 311.2056
  suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
     suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
     with fsv = fs = 311.2056
     with Esv = Es = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.03861577
  2 = Asl,com/(b*d)*(fs2/fc) = 0.08132715
  v = Asl,mid/(b*d)*(fsv/fc) = 0.07196575
and confined core properties:
  b = 540.00
  d = 527.00
  d' = 13.00
  fcc (5A.2, TBDY) = 20.00
   cc (5A.5, TBDY) = 0.002
     c = confinement factor = 1.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.0453489
  2 = Asl,com/(b*d)*(fs2/fc) = 0.09550753
  v = Asl,mid/(b*d)*(fsv/fc) = 0.08451386
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.16341054
Mu = MRc (4.14) = 2.3955E+008
 u =   su (4.1) = 1.0987588E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 u = 1.3683047E-005
Mu = 4.1999E+008
----
with full section properties:
  b = 250.00
  d = 557.00
  d' = 43.00
  v = 0.0031899
   N = 8883.864
  fc = 20.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00768077
     we (5.4c) = 0.01092426
     ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
      The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
      of the rectangular sections confinement, which is expressed by (5.4d).

The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to   bi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00

----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00

----
s = 100.00
fywe = 555.55
fce = 20.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00129669
sh1 = 0.0044814
ft1 = 373.4467
fy1 = 311.2056
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 311.2056
with Es1 = Es = 200000.00
y2 = 0.00129669
sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 311.2056
with Es2 = Es = 200000.00
yv = 0.00129669
shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
 y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
 with fsv = fs = 311.2056
 with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.19518516
2 = Asl,com/(b*d)*(fs2/fc) = 0.09267785
v = Asl,mid/(b*d)*(fsv/fc) = 0.17271781
and confined core properties:
 b = 190.00
 d = 527.00
 d' = 13.00
 fcc (5A.2, TBDY) = 20.00
 cc (5A.5, TBDY) = 0.002
 c = confinement factor = 1.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.27144246
 2 = Asl,com/(b*d)*(fs2/fc) = 0.12888635
 v = Asl,mid/(b*d)*(fsv/fc) = 0.24019729
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
 su (4.8) = 0.32821245
Mu = MRc (4.15) = 4.1999E+008
 u = su (4.1) = 1.3683047E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 u = 1.0987588E-005
Mu = 2.3955E+008
----
with full section properties:
 b = 600.00
 d = 557.00
 d' = 43.00
 v = 0.00132912
 N = 8883.864
 fc = 20.00
 co (5A.5, TBDY) = 0.002
 Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: cu = 0.00768077
 we (5.4c) = 0.01092426
 ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
 The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
 of the rectangular sections confinement, which is expressed by (5.4d).
 The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
 "Theoretical Stress-Strain Model for Confined Concrete."
 J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.

Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to   bi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 555.55
fce = 20.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00129669
sh1 = 0.0044814
ft1 = 373.4467
fy1 = 311.2056
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and   y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 311.2056
with Es1 = Es = 200000.00
y2 = 0.00129669
sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and   y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 311.2056
with Es2 = Es = 200000.00
yv = 0.00129669
shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
 y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
 with fsv = fs = 311.2056
 with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.03861577
2 = Asl,com/(b*d)*(fs2/fc) = 0.08132715
v = Asl,mid/(b*d)*(fsv/fc) = 0.07196575
and confined core properties:
  b = 540.00
  d = 527.00
  d' = 13.00
  fcc (5A.2, TBDY) = 20.00
   cc (5A.5, TBDY) = 0.002
      c = confinement factor = 1.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.0453489
   2 = Asl,com/(b*d)*(fs2/fc) = 0.09550753
   v = Asl,mid/(b*d)*(fsv/fc) = 0.08451386
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.16341054
Mu = MRc (4.14) = 2.3955E+008
 u =   su (4.1) = 1.0987588E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 424229.688

Calculation of Shear Strength at edge 1, Vr1 = 424229.688
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 424229.688
  knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+   f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

     = 1 (normal-weight concrete)
  fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
    Mu = 47.13723
    Vu = 0.00016213
  d = 0.8*h = 480.00
  Nu = 8883.864
  Ag = 150000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 474724.809
  where:
  Vs1 = 139624.944 is calculated for section web, with:
    d = 200.00
    Av = 157079.633
    fy = 444.44
    s = 100.00
  Vs1 is multiplied by Col1 = 1.00
    s/d = 0.50
  Vs2 = 335099.865 is calculated for section flange, with:
    d = 480.00
    Av = 157079.633

```
    fy = 444.44
    s = 100.00
  Vs2 is multiplied by   Col2 = 1.00
    s/d = 0.20833333
  Vf ((11-3)-(11.4), ACI 440) = 0.00
  From (11-11), ACI 440: Vs + Vf <= 356502.845
    bw = 250.00
-------------------------------------------------------------
-------------------------------------------------------------
```

Calculation of Shear Strength at edge 2, Vr2 = 424229.688
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 424229.688
  knl = 1 (zero step-static loading)

```
-------------------------------------------------------------
```
NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
```
-------------------------------------------------------------
```
     = 1 (normal-weight concrete)
  fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
    Mu = 47.13721
    Vu = 0.00016213
  d = 0.8*h = 480.00
  Nu = 8883.864
  Ag = 150000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 474724.809
  where:
  Vs1 = 139624.944 is calculated for section web, with:
    d = 200.00
    Av = 157079.633
    fy = 444.44
    s = 100.00
  Vs1 is multiplied by   Col1 = 1.00
    s/d = 0.50
  Vs2 = 335099.865 is calculated for section flange, with:
    d = 480.00
    Av = 157079.633
    fy = 444.44
    s = 100.00
  Vs2 is multiplied by   Col2 = 1.00
    s/d = 0.20833333
  Vf ((11-3)-(11.4), ACI 440) = 0.00
  From (11-11), ACI 440: Vs + Vf <= 356502.845
    bw = 250.00


```
End Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At local axis: 2

```
-------------------------------------------------------------
```

Start Of Calculation of Chord Rotation Capacity for element: column LC1 of floor 1
At local axis: 2
Integration Section: (b)
Section Type: rclcs

Constant Properties
```
-------------------------------------------------------------
```
Knowledge Factor,   = 1.00
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00

Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lb/ld = 0.30
No FRP Wrapping

Stepwise Properties

Bending Moment, M = -120136.835
Shear Force, V2 = 4235.571
Shear Force, V3 = -145.8655
Axial Force, F = -9654.265
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 4121.77
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1746.726
      -Compression: Asl,com = 829.3805
         -Middle: Asl,mid = 1545.664
Mean Diameter of Tension Reinforcement, DbL = 17.71429

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R =   * θu = 0.00172264
  θu = θy + θp = 0.00172264

 - Calculation of θy -

 θy = (My*Ls/3)/EIeff = 0.00172264 ((4.29),Biskinis Phd))
  My = 2.6304E+008
  Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 823.6137
  From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 4.1921E+013
     factor = 0.30
        Ag = 237500.00
        fc' = 20.00
        N = 9654.265
     Ec*Ig = 1.3974E+014

Calculation of Yielding Moment My

Calculation of θy and My according to Annex 7   -

  θy = Min(θy_ten, θy_com)
  θy_ten = 3.6312890E-006
  with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 248.9644
     d = 557.00
      ξy = 0.38455208
     A = 0.02987826
     B = 0.0192605
      with pt = 0.01254381
         pc = 0.00595605
         pv = 0.01109992
         N = 9654.265
         b = 250.00

```
        " = 0.07719928
  y_comp = 8.0241107E-006
 with fc = 20.00
     Ec = 21019.039
      y = 0.38321062
      A = 0.02939738
      B = 0.01898202
      with Es = 200000.00
------------------------------------------------------------
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30


------------------------------------------------------------
 - Calculation of  p -
------------------------------------------------------------
From table 10-8:  p = 0.00
with:
 - Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
   shear control ratio VyE/VCol0E = 0.66001051
   d = 557.00
   s = 0.00
    t = Av/(bw*s) + 2*tf/bw*(ffe/fs) = Av*Lstir/(Ag*s) + 2*tf/bw*(ffe/fs) = 0.00
   Av = 78.53982, is the area of every stirrup
   Lstir = 1460.00, is the total Length of all stirrups parallel to loading (shear) direction
   The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
   where   f = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises  f to steel strength
   All these variables have already been given in Shear control ratio calculation.
    NUD = 9654.265
    Ag = 237500.00
    f'cE = 20.00
    fytE = fylE = 0.00
pl = Area_Tot_Long_Rein/(b*d) = 0.02959978
   b = 250.00
   d = 557.00
    f'cE = 20.00
------------------------------------------------------------
End Of Calculation of Chord Rotation Capacity for element: column LC1 of floor 1
At local axis: 2
Integration Section: (b)


------------------------------------------------------------
```

Calculation No. 7

column C1, Floor 1

Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (3)

Start Of Calculation of Shear Capacity for element: column LC1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rclcs

Constant Properties

Knowledge Factor,   = 1.00
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of   y for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE41-17).
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.44
##
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min =lb/ld = 0.30
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -315855.788
Shear Force, Va = 145.8655
EDGE -B-
Bending Moment, Mb = -120136.835
Shear Force, Vb = -145.8655
BOTH EDGES
Axial Force, F = -9654.265
Longitudinal Reinforcement Area Distribution (in 2 divisions)
    -Tension: Aslt = 0.00
  -Compression: Aslc = 4121.77
Longitudinal Reinforcement Area Distribution (in 3 divisions)
    -Tension: Asl,ten = 1746.726
  -Compression: Asl,com = 829.3805
    -Middle: Asl,mid = 1545.664
Mean Diameter of Tension Reinforcement, DbL,ten = 17.71429

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR =   *Vn = 440356.038
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 440356.038
  VCol = 440356.038
  knl = 1.00
    displacement_ductility_demand = 1.3557591E-005

NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

    = 1 (normal-weight concrete)
  fc' = 16.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
    Mu = 120136.835
    Vu = 145.8655
  d = 0.8*h = 480.00
  Nu = 9654.265
  Ag = 150000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 427256.601
  where:
  Vs1 = 301592.895 is calculated for section web, with:
    d = 480.00
    Av = 157079.633
    fy = 400.00
    s = 100.00
  Vs1 is multiplied by   Col1 = 1.00
    s/d = 0.20833333
  Vs2 = 125663.706 is calculated for section flange, with:
    d = 200.00
    Av = 157079.633
    fy = 400.00
    s = 100.00
  Vs2 is multiplied by   Col2 = 1.00
    s/d = 0.50
  Vf ((11-3)-(11.4), ACI 440) = 0.00
  From (11-11), ACI 440: Vs + Vf <= 318865.838
    bw = 250.00

----
displacement_ductility_demand is calculated as   / y

 - Calculation of   / y for END B -
 for rotation axis 2 and integ. section (b)

From analysis, chord rotation   = 2.3354821E-008
 y = (My*Ls/3)/Eleff = 0.00172264 ((4.29),Biskinis Phd))
  My = 2.6304E+008

Ls = M/V (with Ls > 0.1*L and Ls < 2*L) = 823.6137
From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 4.1921E+013
  factor = 0.30
    Ag = 237500.00
    fc' = 20.00
    N = 9654.265
  Ec*Ig = 1.3974E+014

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7 -
----
 y = Min(y_ten, y_com)
 y_ten = 3.6312890E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 248.9644
    d = 557.00
    y = 0.38455208
    A = 0.02987826
    B = 0.0192605
     with pt = 0.01254381
       pc = 0.00595605
       pv = 0.01109992
       N = 9654.265
       b = 250.00
       " = 0.07719928
 y_comp = 8.0241107E-006
with fc = 20.00
    Ec = 21019.039
    y = 0.38321062
    A = 0.02939738
    B = 0.01898202
     with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

End Of Calculation of Shear Capacity for element: column LC1 of floor 1
At local axis: 3
Integration Section: (b)

Calculation No. 8

column C1, Floor 1

Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (u)

Edge: End

Local Axis: (3)

Start Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rclcs

Constant Properties

Knowledge Factor,   = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55
##
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-

Shear Force, Va = 0.00016213
EDGE -B-
Shear Force, Vb = -0.00016213
BOTH EDGES
Axial Force, F = -8883.864
Longitudinal Reinforcement Area Distribution (in 2 divisions)
     -Tension: Aslt = 0.00
   -Compression: Aslc = 4121.77
Longitudinal Reinforcement Area Distribution (in 3 divisions)
     -Tension: Asl,ten = 1746.726
   -Compression: Asl,com = 829.3805
      -Middle: Asl,mid = 1545.664

Calculation of Shear Capacity ratio , Ve/Vr = 0.66001051
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 279996.052
with
Mpr1 = Max(Mu1+ , Mu1-) = 4.1999E+008
  Mu1+ = 4.1999E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
  Mu1- = 2.3955E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 4.1999E+008
  Mu2+ = 4.1999E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
  Mu2- = 2.3955E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.3683047E-005
Mu = 4.1999E+008
----
with full section properties:
  b = 250.00
  d = 557.00
  d' = 43.00
  v = 0.0031899
    N = 8883.864
  fc = 20.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: cu = 0.00768077
       we (5.4c) = 0.01092426
       ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
          The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
          of the rectangular sections confinement, which is expressed by (5.4d).
          The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
          "Theoretical Stress-Strain Model for Confined Concrete."
          J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
          Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
               is calculated as the area of core enclosed by the center lines of the perimeter hoops.
          Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
               is calculated by reducing all the dimensions of the area Aconf,max by a length
               equal to half the clear spacing between hoops.
          AnoConf = 105733.333 is the unconfined core area which is equal to bi2/6 as defined at (A.2).
       psh,min = Min(psh,x , psh,y) = 0.00482813
     Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

```
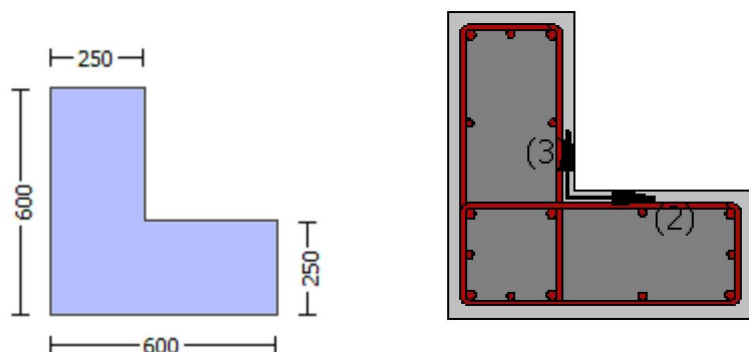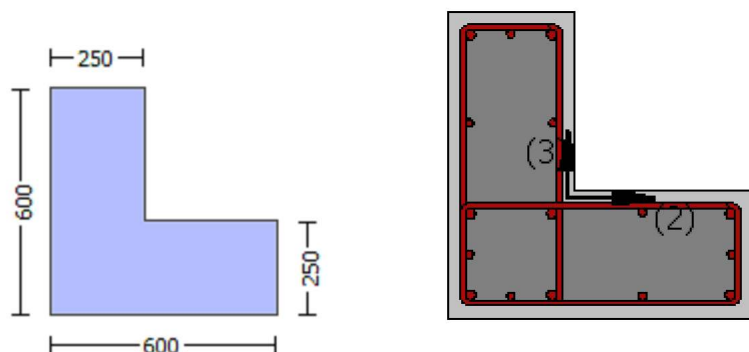-------------------------------------------------------------------
    psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
        Lstir (Length of stirrups along Y) = 1460.00
        Astir (stirrups area) = 78.53982
        Asec (section area) = 237500.00
-------------------------------------------------------------------
    psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
        Lstir (Length of stirrups along X) = 1460.00
        Astir (stirrups area) = 78.53982
        Asec (section area) = 237500.00
-------------------------------------------------------------------
        s = 100.00
      fywe = 555.55
      fce = 20.00
    From ((5.A5), TBDY), TBDY:  cc = 0.002
        c = confinement factor = 1.00
  y1 = 0.00129669
  sh1 = 0.0044814
ft1 = 373.4467
fy1 = 311.2056
  su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
      su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
      with fs1 = fs = 311.2056
      with Es1 = Es = 200000.00
  y2 = 0.00129669
  sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
  su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.30
      su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
      with fs2 = fs = 311.2056
      with Es2 = Es = 200000.00
  yv = 0.00129669
  shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
  suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
      suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and  yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
      with fsv = fs = 311.2056
      with Esv = Es = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.19518516
    2 = Asl,com/(b*d)*(fs2/fc) = 0.09267785
```

```
        v = Asl,mid/(b*d)*(fsv/fc) = 0.17271781
and confined core properties:
   b = 190.00
   d = 527.00
   d' = 13.00
  fcc (5A.2, TBDY) = 20.00
    cc (5A.5, TBDY) = 0.002
       c = confinement factor = 1.00
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.27144246
     2 = Asl,com/(b*d)*(fs2/fc) = 0.12888635
        v = Asl,mid/(b*d)*(fsv/fc) = 0.24019729
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
  su (4.8) = 0.32821245
Mu = MRc (4.15) = 4.1999E+008
  u =    su (4.1) = 1.3683047E-005
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
----------------------------------------------------------------------
----------------------------------------------------------------------
----------------------------------------------------------------------
Calculation of Mu1-
----------------------------------------------------------------------

----------------------------------------------------------------------
Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
   u = 1.0987588E-005
Mu = 2.3955E+008
----------------------------------------------------------------------
with full section properties:
   b = 600.00
   d = 557.00
   d' = 43.00
   v = 0.00132912
      N = 8883.864
   fc = 20.00
    co (5A.5, TBDY) = 0.002
   Final value of  cu:  cu* = shear_factor * Max( cu, cc) = 0.00768077
      The Shear_factor is considered equal to 1 (pure moment strength)
      From (5.4b), TBDY:  cu = 0.00768077
        we (5.4c) = 0.01092426
       ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
          The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
          of the rectangular sections confinement, which is expressed by (5.4d).
          The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
          "Theoretical Stress-Strain Model for Confined Concrete."
          J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
          Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
                 is calculated as the area of core enclosed by the center lines of the perimeter hoops.
          Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
                 is calculated by reducing all the dimensions of the area Aconf,max by a length
                 equal to half the clear spacing between hoops.
          AnoConf = 105733.333 is the unconfined core area which is equal to  bi2/6 as defined at (A.2).
        psh,min = Min(psh,x , psh,y) = 0.00482813
      Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
        ----------------------------------------------------------------
          psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
            Lstir (Length of stirrups along Y) = 1460.00
```

```
            Astir (stirrups area) = 78.53982
            Asec (section area) = 237500.00
    ------------------------------------------------------------------
       psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
            Lstir (Length of stirrups along X) = 1460.00
            Astir (stirrups area) = 78.53982
            Asec (section area) = 237500.00
    ------------------------------------------------------------------
            s = 100.00
           fywe = 555.55
           fce  = 20.00
      From ((5.A5), TBDY), TBDY:  cc = 0.002
            c  = confinement factor = 1.00
     y1 = 0.00129669
    sh1 = 0.0044814
   ft1 = 373.4467
   fy1 = 311.2056
    su1 = 0.00512
       using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
       and also multiplied by the shear_factor according to 15.7.1.4, with
       Shear_factor = 1.00
       lo/lou,min = lb/ld = 0.30
        su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
       From table 5A.1, TBDY: esu1_nominal = 0.08,
       For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
       characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
        y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
        with fs1 = fs = 311.2056
        with Es1 = Es = 200000.00
     y2 = 0.00129669
    sh2 = 0.0044814
   ft2 = 373.4467
   fy2 = 311.2056
    su2 = 0.00512
       using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
       and also multiplied by the shear_factor according to 15.7.1.4, with
       Shear_factor = 1.00
       lo/lou,min = lb/lb,min = 0.30
        su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
       From table 5A.1, TBDY: esu2_nominal = 0.08,
       For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
       characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
        y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
        with fs2 = fs = 311.2056
        with Es2 = Es = 200000.00
     yv = 0.00129669
    shv = 0.0044814
   ftv = 373.4467
   fyv = 311.2056
    suv = 0.00512
       using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
       and also multiplied by the shear_factor according to 15.7.1.4, with
       Shear_factor = 1.00
       lo/lou,min = lb/ld = 0.30
        suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
       From table 5A.1, TBDY: esuv_nominal = 0.08,
       considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
       For calculation of esuv_nominal and  yv, shv,ftv,fyv, it is considered
       characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
        y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
        with fsv = fs = 311.2056
        with Esv = Es = 200000.00
      1 = Asl,ten/(b*d)*(fs1/fc) = 0.03861577
      2 = Asl,com/(b*d)*(fs2/fc) = 0.08132715
      v = Asl,mid/(b*d)*(fsv/fc) = 0.07196575
and confined core properties:
  b = 540.00
```

```
   d = 527.00
   d' = 13.00
  fcc (5A.2, TBDY) = 20.00
   cc (5A.5, TBDY) = 0.002
      c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.0453489
    2 = Asl,com/(b*d)*(fs2/fc) = 0.09550753
    v = Asl,mid/(b*d)*(fsv/fc) = 0.08451386
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.16341054
Mu = MRc (4.14) = 2.3955E+008
 u =   su (4.1) = 1.0987588E-005
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
--------------------------------------------------------------------
--------------------------------------------------------------------
--------------------------------------------------------------------
Calculation of Mu2+
--------------------------------------------------------------------

--------------------------------------------------------------------
Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.3683047E-005
Mu = 4.1999E+008
--------------------------------------------------------------------
with full section properties:
  b = 250.00
  d = 557.00
  d' = 43.00
  v = 0.0031899
    N = 8883.864
  fc = 20.00
   co (5A.5, TBDY) = 0.002
  Final value of  cu:  cu* = shear_factor * Max( cu, cc) = 0.00768077
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY:  cu = 0.00768077
       we (5.4c) = 0.01092426
       ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
           The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
           of the rectangular sections confinement, which is expressed by (5.4d).
           The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
           "Theoretical Stress-Strain Model for Confined Concrete."
           J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
           Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
                   is calculated as the area of core enclosed by the center lines of the perimeter hoops.
           Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
                   is calculated by reducing all the dimensions of the area Aconf,max by a length
                   equal to half the clear spacing between hoops.
           AnoConf = 105733.333 is the unconfined core area which is equal to  bi2/6 as defined at (A.2).
       psh,min = Min(psh,x , psh,y) = 0.00482813
     Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
       ----------------------------------------------------------------
       psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
           Lstir (Length of stirrups along Y) = 1460.00
           Astir (stirrups area) = 78.53982
           Asec (section area) = 237500.00
       ----------------------------------------------------------------
       psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
           Lstir (Length of stirrups along X) = 1460.00
```

Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 555.55
fce = 20.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00129669
sh1 = 0.0044814
ft1 = 373.4467
fy1 = 311.2056
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 311.2056
with Es1 = Es = 200000.00
y2 = 0.00129669
sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 311.2056
with Es2 = Es = 200000.00
yv = 0.00129669
shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 311.2056
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.19518516
2 = Asl,com/(b*d)*(fs2/fc) = 0.09267785
v = Asl,mid/(b*d)*(fsv/fc) = 0.17271781
and confined core properties:
b = 190.00
d = 527.00
d' = 13.00
fcc (5A.2, TBDY) = 20.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00

```
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.27144246
    2 = Asl,com/(b*d)*(fs2/fc) = 0.12888635
    v = Asl,mid/(b*d)*(fsv/fc) = 0.24019729
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
 su (4.8) = 0.32821245
Mu = MRc (4.15) = 4.1999E+008
  u =   su (4.1) = 1.3683047E-005
-------------------------------------------------------------
```

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.0987588E-005
Mu = 2.3955E+008
----
with full section properties:
  b = 600.00
  d = 557.00
  d' = 43.00
  v = 0.00132912
    N = 8883.864
  fc = 20.00
   co (5A.5, TBDY) = 0.002
  Final value of   cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00768077
      we (5.4c) = 0.01092426
      ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
          The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
          of the rectangular sections confinement, which is expressed by (5.4d).
          The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
          "Theoretical Stress-Strain Model for Confined Concrete."
          J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
          Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
                is calculated as the area of core enclosed by the center lines of the perimeter hoops.
          Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
                is calculated by reducing all the dimensions of the area Aconf,max by a length
                equal to half the clear spacing between hoops.
          AnoConf = 105733.333 is the unconfined core area which is equal to   bi2/6 as defined at (A.2).
        psh,min = Min(psh,x , psh,y) = 0.00482813
     Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

      ----
        psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
          Lstir (Length of stirrups along Y) = 1460.00
          Astir (stirrups area) = 78.53982
          Asec (section area) = 237500.00
      ----
        psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
          Lstir (Length of stirrups along X) = 1460.00
          Astir (stirrups area) = 78.53982
          Asec (section area) = 237500.00

```
        s = 100.00
      fywe = 555.55
       fce = 20.00
   From ((5.A5), TBDY), TBDY:  cc = 0.002
       c = confinement factor = 1.00
  y1 = 0.00129669
  sh1 = 0.0044814
 ft1 = 373.4467
 fy1 = 311.2056
  su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
     su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
     with fs1 = fs = 311.2056
     with Es1 = Es = 200000.00
  y2 = 0.00129669
  sh2 = 0.0044814
 ft2 = 373.4467
 fy2 = 311.2056
  su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.30
     su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
     with fs2 = fs = 311.2056
     with Es2 = Es = 200000.00
  yv = 0.00129669
  shv = 0.0044814
 ftv = 373.4467
 fyv = 311.2056
  suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
     suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and  yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
     with fsv = fs = 311.2056
     with Esv = Es = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.03861577
    2 = Asl,com/(b*d)*(fs2/fc) = 0.08132715
    v = Asl,mid/(b*d)*(fsv/fc) = 0.07196575
 and confined core properties:
  b = 540.00
  d = 527.00
  d' = 13.00
  fcc (5A.2, TBDY) = 20.00
   cc (5A.5, TBDY) = 0.002
       c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.0453489
    2 = Asl,com/(b*d)*(fs2/fc) = 0.09550753
    v = Asl,mid/(b*d)*(fsv/fc) = 0.08451386
```

Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.16341054
Mu = MRc (4.14) = 2.3955E+008
  u =   su (4.1) = 1.0987588E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 424229.688

Calculation of Shear Strength at edge 1, Vr1 = 424229.688
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 424229.688
  knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+   f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

    = 1 (normal-weight concrete)
  fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
     Mu = 47.14131
     Vu = 0.00016213
  d = 0.8*h = 480.00
  Nu = 8883.864
  Ag = 150000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 474724.809
  where:
  Vs1 = 335099.865 is calculated for section web, with:
    d = 480.00
    Av = 157079.633
    fy = 444.44
    s = 100.00
  Vs1 is multiplied by   Col1 = 1.00
    s/d = 0.20833333
  Vs2 = 139624.944 is calculated for section flange, with:
    d = 200.00
    Av = 157079.633
    fy = 444.44
    s = 100.00
  Vs2 is multiplied by   Col2 = 1.00
    s/d = 0.50
  Vf ((11-3)-(11.4), ACI 440) = 0.00
  From (11-11), ACI 440: Vs + Vf <= 356502.845
    bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 424229.688
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 424229.688
  knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+   f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

    = 1 (normal-weight concrete)
  fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00

Mu = 47.14134
Vu = 0.00016213
d = 0.8*h = 480.00
Nu = 8883.864
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 474724.809
where:
Vs1 = 335099.865 is calculated for section web, with:
  d = 480.00
  Av = 157079.633
  fy = 444.44
  s = 100.00
Vs1 is multiplied by   Col1 = 1.00
  s/d = 0.20833333
Vs2 = 139624.944 is calculated for section flange, with:
  d = 200.00
  Av = 157079.633
  fy = 444.44
  s = 100.00
Vs2 is multiplied by   Col2 = 1.00
  s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 356502.845
  bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rclcs

Constant Properties

Knowledge Factor,   = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55
##
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = 0.00016213
EDGE -B-
Shear Force, Vb = -0.00016213
BOTH EDGES
Axial Force, F = -8883.864
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
    -Compression: Aslc = 4121.77
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1746.726
     -Compression: Asl,com = 829.3805
         -Middle: Asl,mid = 1545.664

Calculation of Shear Capacity ratio , Ve/Vr = 0.66001051
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 279996.052
with
Mpr1 = Max(Mu1+ , Mu1-) = 4.1999E+008
  Mu1+ = 4.1999E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
  Mu1- = 2.3955E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 4.1999E+008
  Mu2+ = 4.1999E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
  Mu2- = 2.3955E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.3683047E-005
Mu = 4.1999E+008
----
with full section properties:
  b = 250.00
  d = 557.00
  d' = 43.00
  v = 0.0031899
    N = 8883.864
  fc = 20.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00768077
      we (5.4c) = 0.01092426
      ase = Max((((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
                is calculated as the area of core enclosed by the center lines of the perimeter hoops.
        Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
                is calculated by reducing all the dimensions of the area Aconf,max by a length
                equal to half the clear spacing between hoops.

AnoConf = 105733.333 is the unconfined core area which is equal to   bi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

----

psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00

----

psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00

----

s = 100.00
fywe = 555.55
fce = 20.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00129669
sh1 = 0.0044814
ft1 = 373.4467
fy1 = 311.2056
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 311.2056
with Es1 = Es = 200000.00
y2 = 0.00129669
sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 311.2056
with Es2 = Es = 200000.00
yv = 0.00129669
shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.

with fsv = fs = 311.2056
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.19518516
2 = Asl,com/(b*d)*(fs2/fc) = 0.09267785
v = Asl,mid/(b*d)*(fsv/fc) = 0.17271781
and confined core properties:
b = 190.00
d = 527.00
d' = 13.00
fcc (5A.2, TBDY) = 20.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.27144246
2 = Asl,com/(b*d)*(fs2/fc) = 0.12888635
v = Asl,mid/(b*d)*(fsv/fc) = 0.24019729
Case/Assumption: Unconfinesd full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.8) = 0.32821245
Mu = MRc (4.15) = 4.1999E+008
u =   su (4.1) = 1.3683047E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
u = 1.0987588E-005
Mu = 2.3955E+008
----
with full section properties:
b = 600.00
d = 557.00
d' = 43.00
v = 0.00132912
N = 8883.864
fc = 20.00
co (5A.5, TBDY) = 0.002
Final value of   cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00768077
we (5.4c) = 0.01092426
ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to   bi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without

earthquake detailing (90° closed stirrups)

```
        ----------------------------------------------------------------
            psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
                Lstir (Length of stirrups along Y) = 1460.00
                Astir (stirrups area) = 78.53982
                Asec (section area) = 237500.00
        ----------------------------------------------------------------
            psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
                Lstir (Length of stirrups along X) = 1460.00
                Astir (stirrups area) = 78.53982
                Asec (section area) = 237500.00
        ----------------------------------------------------------------
                s = 100.00
            fywe = 555.55
            fce  = 20.00
       From ((5.A5), TBDY), TBDY:  cc = 0.002
             c = confinement factor = 1.00
     y1 = 0.00129669
    sh1 = 0.0044814
   ft1 = 373.4467
   fy1 = 311.2056
    su1 = 0.00512
       using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
       and also multiplied by the shear_factor according to 15.7.1.4, with
       Shear_factor = 1.00
       lo/lou,min = lb/ld = 0.30
        su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
       From table 5A.1, TBDY: esu1_nominal = 0.08,
       For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
       characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
        y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
         with fs1 = fs = 311.2056
         with Es1 = Es = 200000.00
     y2 = 0.00129669
    sh2 = 0.0044814
   ft2 = 373.4467
   fy2 = 311.2056
    su2 = 0.00512
       using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
       and also multiplied by the shear_factor according to 15.7.1.4, with
       Shear_factor = 1.00
       lo/lou,min = lb/lb,min = 0.30
        su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
       From table 5A.1, TBDY: esu2_nominal = 0.08,
       For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
       characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
        y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
         with fs2 = fs = 311.2056
         with Es2 = Es = 200000.00
     yv = 0.00129669
    shv = 0.0044814
   ftv = 373.4467
   fyv = 311.2056
    suv = 0.00512
       using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
       and also multiplied by the shear_factor according to 15.7.1.4, with
       Shear_factor = 1.00
       lo/lou,min = lb/ld = 0.30
        suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
       From table 5A.1, TBDY: esuv_nominal = 0.08,
       considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
       For calculation of esuv_nominal and  yv, shv,ftv,fyv, it is considered
       characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
        y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
         with fsv = fs = 311.2056
         with Esv = Es = 200000.00
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.03861577
```

```
    2 = Asl,com/(b*d)*(fs2/fc) = 0.08132715
    v = Asl,mid/(b*d)*(fsv/fc) = 0.07196575
and confined core properties:
  b = 540.00
  d = 527.00
  d' = 13.00
  fcc (5A.2, TBDY) = 20.00
   cc (5A.5, TBDY) = 0.002
     c  = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.0453489
    2 = Asl,com/(b*d)*(fs2/fc) = 0.09550753
    v = Asl,mid/(b*d)*(fsv/fc) = 0.08451386
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.16341054
Mu = MRc (4.14) = 2.3955E+008
  u =    su (4.1) = 1.0987588E-005
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
----------------------------------------------------------------------
----------------------------------------------------------------------
----------------------------------------------------------------------
Calculation of Mu2+
----------------------------------------------------------------------

----------------------------------------------------------------------
Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.3683047E-005
Mu = 4.1999E+008
----------------------------------------------------------------------
with full section properties:
  b = 250.00
  d = 557.00
  d' = 43.00
  v = 0.0031899
    N = 8883.864
  fc = 20.00
   co (5A.5, TBDY) = 0.002
  Final value of   cu:  cu* = shear_factor * Max( cu,  cc) = 0.00768077
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY:  cu = 0.00768077
      we (5.4c) = 0.01092426
      ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
         The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
         of the rectangular sections confinement, which is expressed by (5.4d).
         The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
         "Theoretical Stress-Strain Model for Confined Concrete."
         J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
         Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
               is calculated as the area of core enclosed by the center lines of the perimeter hoops.
         Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
               is calculated by reducing all the dimensions of the area Aconf,max by a length
               equal to half the clear spacing between hoops.
         AnoConf = 105733.333 is the unconfined core area which is equal to   bi2/6 as defined at (A.2).
      psh,min = Min(psh,x , psh,y) = 0.00482813
    Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
      ----------------------------------------------------------------
         psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
           Lstir (Length of stirrups along Y) = 1460.00
           Astir (stirrups area) = 78.53982
```

Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 555.55
fce = 20.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00129669
sh1 = 0.0044814
ft1 = 373.4467
fy1 = 311.2056
su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
    with fs1 = fs = 311.2056
    with Es1 = Es = 200000.00
y2 = 0.00129669
sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.30
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
    with fs2 = fs = 311.2056
    with Es2 = Es = 200000.00
yv = 0.00129669
shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
    with fsv = fs = 311.2056
    with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.19518516
2 = Asl,com/(b*d)*(fs2/fc) = 0.09267785
v = Asl,mid/(b*d)*(fsv/fc) = 0.17271781
and confined core properties:
b = 190.00
d = 527.00

```
   d' = 13.00
  fcc (5A.2, TBDY) = 20.00
   cc (5A.5, TBDY) = 0.002
      c  = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.27144246
    2 = Asl,com/(b*d)*(fs2/fc) = 0.12888635
    v = Asl,mid/(b*d)*(fsv/fc) = 0.24019729
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
 su (4.8) = 0.32821245
Mu = MRc (4.15) = 4.1999E+008
 u =    su (4.1) = 1.3683047E-005
-------------------------------------------------------------

Calculation of ratio lb/ld
-------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
----------------------------------------------------------------------------
----------------------------------------------------------------------------
----------------------------------------------------------------------------
Calculation of Mu2-
----------------------------------------------------------------------------

----------------------------------------------------------------------------
Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.0987588E-005
Mu = 2.3955E+008
----------------------------------------------------------------------------
with full section properties:
  b = 600.00
  d = 557.00
  d' = 43.00
  v = 0.00132912
    N = 8883.864
  fc = 20.00
   co (5A.5, TBDY) = 0.002
  Final value of  cu:  cu* = shear_factor * Max( cu, cc) = 0.00768077
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY:  cu = 0.00768077
      we (5.4c) = 0.01092426
      ase = Max((((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
              is calculated as the area of core enclosed by the center lines of the perimeter hoops.
        Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
              is calculated by reducing all the dimensions of the area Aconf,max by a length
              equal to half the clear spacing between hoops.
        AnoConf = 105733.333 is the unconfined core area which is equal to   bi2/6 as defined at (A.2).
      psh,min = Min(psh,x , psh,y) = 0.00482813
    Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

      ----------------------------------------------------------------------
      psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
        Lstir (Length of stirrups along Y) = 1460.00
        Astir (stirrups area) = 78.53982
        Asec (section area) = 237500.00
      ----------------------------------------------------------------------
      psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
```

Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00

----

s = 100.00
fywe = 555.55
fce = 20.00
From ((5.A5), TBDY): cc = 0.002
c = confinement factor = 1.00
y1 = 0.00129669
sh1 = 0.0044814
ft1 = 373.4467
fy1 = 311.2056
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 311.2056
with Es1 = Es = 200000.00
y2 = 0.00129669
sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 311.2056
with Es2 = Es = 200000.00
yv = 0.00129669
shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 311.2056
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.03861577
2 = Asl,com/(b*d)*(fs2/fc) = 0.08132715
v = Asl,mid/(b*d)*(fsv/fc) = 0.07196575
and confined core properties:
b = 540.00
d = 527.00
d' = 13.00
fcc (5A.2, TBDY) = 20.00
cc (5A.5, TBDY) = 0.002

```
     c  = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.0453489
    2 = Asl,com/(b*d)*(fs2/fc) = 0.09550753
    v = Asl,mid/(b*d)*(fsv/fc) = 0.08451386
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.16341054
Mu = MRc (4.14) = 2.3955E+008
  u =   su (4.1) = 1.0987588E-005
 -------------------------------------------------------------

Calculation of ratio lb/ld
 -------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
 ---------------------------------------------------------------------
 ---------------------------------------------------------------------
 ---------------------------------------------------------------------
 ---------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 424229.688
 ---------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 424229.688
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 424229.688
  knl = 1 (zero step-static loading)
 -------------------------------------------------------------
NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+   f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
 -------------------------------------------------------------
     = 1 (normal-weight concrete)
  fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
     Mu = 47.13723
     Vu = 0.00016213
  d = 0.8*h = 480.00
  Nu = 8883.864
  Ag = 150000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 474724.809
  where:
  Vs1 = 139624.944 is calculated for section web, with:
   d = 200.00
   Av = 157079.633
   fy = 444.44
   s = 100.00
  Vs1 is multiplied by   Col1 = 1.00
    s/d = 0.50
  Vs2 = 335099.865 is calculated for section flange, with:
   d = 480.00
   Av = 157079.633
   fy = 444.44
   s = 100.00
  Vs2 is multiplied by   Col2 = 1.00
    s/d = 0.20833333
  Vf ((11-3)-(11.4), ACI 440) = 0.00
  From (11-11), ACI 440: Vs + Vf <= 356502.845
    bw = 250.00
 -------------------------------------------------------------

 ---------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 424229.688
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 424229.688
  knl = 1 (zero step-static loading)
 -------------------------------------------------------------
NOTE: In expression (10-3) 'Vs'  is replaced by 'Vs   f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
```

```
------------------------------------------------------------
    = 1 (normal-weight concrete)
  fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
      Mu = 47.13721
      Vu = 0.00016213
  d = 0.8*h = 480.00
  Nu = 8883.864
  Ag = 150000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 474724.809
  where:
  Vs1 = 139624.944 is calculated for section web, with:
    d = 200.00
    Av = 157079.633
    fy = 444.44
    s = 100.00
  Vs1 is multiplied by   Col1 = 1.00
    s/d = 0.50
  Vs2 = 335099.865 is calculated for section flange, with:
    d = 480.00
    Av = 157079.633
    fy = 444.44
    s = 100.00
  Vs2 is multiplied by   Col2 = 1.00
    s/d = 0.20833333
  Vf ((11-3)-(11.4), ACI 440) = 0.00
  From (11-11), ACI 440: Vs + Vf <= 356502.845
    bw = 250.00
------------------------------------------------------------
------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At local axis: 2


------------------------------------------------------------


Start Of Calculation of Chord Rotation Capacity for element: column LC1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rclcs

Constant Properties
------------------------------------------------------------
Knowledge Factor,    = 1.00
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lb/ld = 0.30
No FRP Wrapping
------------------------------------------------------------

Stepwise Properties
```

Bending Moment, M = 163326.01
Shear Force, V2 = 4235.571
Shear Force, V3 = -145.8655
Axial Force, F = -9654.265
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
    -Compression: Aslc = 4121.77
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1746.726
    -Compression: Asl,com = 829.3805
        -Middle: Asl,mid = 1545.664
Mean Diameter of Tension Reinforcement, DbL = 17.71429

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $\theta u,R = \kappa * \theta u = 0.00062747$
 $\theta u = \theta y + \theta p = 0.00062747$

 - Calculation of θy -

 $\theta y = (My*Ls/3)/EIeff = 0.00062747$ ((4.29),Biskinis Phd))
 My = 2.6304E+008
 Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 300.00
 From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 4.1921E+013
    factor = 0.30
      Ag = 237500.00
      fc' = 20.00
      N = 9654.265
    Ec*Ig = 1.3974E+014

Calculation of Yielding Moment My

Calculation of θy and My according to Annex 7   -

 $\theta y = Min(\theta y\_ten, \theta y\_com)$
 $\theta y\_ten = 3.6312890E-006$
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 248.9644
    d = 557.00
     $\xi y = 0.38455208$
    A = 0.02987826
    B = 0.0192605
     with pt = 0.01254381
        pc = 0.00595605
        pv = 0.01109992
        N = 9654.265
        b = 250.00
        " = 0.07719928
 $\theta y\_comp = 8.0241107E-006$
 with fc = 20.00
    Ec = 21019.039
     $\xi y = 0.38321062$
    A = 0.02939738
    B = 0.01898202
     with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

- Calculation of p -

From table 10-8: p = 0.00
with:
 - Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
   shear control ratio VyE/VCol0E = 0.66001051
   d = 557.00
   s = 0.00
    t = Av/(bw*s) + 2*tf/bw*(ffe/fs) = Av*Lstir/(Ag*s) + 2*tf/bw*(ffe/fs) = 0.00
   Av = 78.53982, is the area of every stirrup
   Lstir = 1460.00, is the total Length of all stirrups parallel to loading (shear) direction
   The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
   where   f = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises f to steel strength
   All these variables have already been given in Shear control ratio calculation.
    NUD = 9654.265
    Ag = 237500.00
    f'cE = 20.00
    fytE = fylE = 0.00
pl = Area_Tot_Long_Rein/(b*d) = 0.02959978
   b = 250.00
   d = 557.00
    f'cE = 20.00

End Of Calculation of Chord Rotation Capacity for element: column LC1 of floor 1
At local axis: 3
Integration Section: (b)

Calculation No. 9

column C1, Floor 1

Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (2)

Start Of Calculation of Shear Capacity for element: column LC1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rclcs

Constant Properties

Knowledge Factor,   = 1.00
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of y for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE41-17).
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.44
##
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min =lb/ld = 0.30
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -1.0691E+007
Shear Force, Va = -3517.163
EDGE -B-
Bending Moment, Mb = 135615.782
Shear Force, Vb = 3517.163
BOTH EDGES
Axial Force, F = -9523.595
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
    -Compression: Aslc = 4121.77
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 1746.726
    -Compression: Asl,com = 829.3805
      -Middle: Asl,mid = 1545.664
Mean Diameter of Tension Reinforcement, DbL,ten = 17.71429

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR =   *Vn = 379598.075
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 379598.075
   VCol = 379598.075
   knl = 1.00
      displacement_ductility_demand = 0.01644417

NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+ɸf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

    λ = 1 (normal-weight concrete)
  fc' = 16.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
    Mu = 1.0691E+007
    Vu = 3517.163
  d = 0.8*h = 480.00
  Nu = 9523.595
  Ag = 150000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 427256.601
  where:
  Vs1 = 125663.706 is calculated for section web, with:
    d = 200.00
    Av = 157079.633
    fy = 400.00
    s = 100.00
  Vs1 is multiplied by   Col1 = 1.00
    s/d = 0.50
  Vs2 = 301592.895 is calculated for section flange, with:
    d = 480.00
    Av = 157079.633
    fy = 400.00
    s = 100.00
  Vs2 is multiplied by   Col2 = 1.00
    s/d = 0.20833333
  Vf ((11-3)-(11.4), ACI 440) = 0.00
  From (11-11), ACI 440: Vs + Vf <= 318865.838
    bw = 250.00

----
displacement_ductility_demand is calculated as θ / θy

 - Calculation of θ / θy for END A -
 for rotation axis 3 and integ. section (a)

From analysis, chord rotation θ   = 0.00010453
 θy = (My*Ls/3)/EIeff = 0.00635684 ((4.29),Biskinis Phd))
  My = 2.6302E+008
  Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3039.574
  From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 4.1921E+013
    factor = 0.30
      Ag = 237500.00
      fc' = 20.00
      N = 9523.595
    Ec*Ig = 1.3974E+014

Calculation of Yielding Moment My

Calculation of θy and My according to Annex 7   -

  θy = Min(θy_ten, θy_com)
  θy_ten = 3.6310943E-006
  with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 248.9644
    d = 557.00
    ξy = 0.38451907
    A = 0.02987449
    B = 0.01925673
    with pt = 0.01254381
      pc = 0.00595605
      pv = 0.01109992
      N = 9523.595
      b = 250.00

" = 0.07719928
  y_comp = 8.0244262E-006
 with fc = 20.00
     Ec = 21019.039
      y = 0.38319556
      A = 0.02940012
      B = 0.01898202
     with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

End Of Calculation of Shear Capacity for element: column LC1 of floor 1
At local axis: 2
Integration Section: (a)

Calculation No. 10

column C1, Floor 1

Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (u)

Edge: Start

Local Axis: (2)

Start Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rclcs

Constant Properties

Knowledge Factor,   = 1.00
Mean strength values are used for both shear and moment calculations.

Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55
###
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = 0.00016213
EDGE -B-
Shear Force, Vb = -0.00016213
BOTH EDGES
Axial Force, F = -8883.864
Longitudinal Reinforcement Area Distribution (in 2 divisions)
       -Tension: Aslt = 0.00
    -Compression: Aslc = 4121.77
Longitudinal Reinforcement Area Distribution (in 3 divisions)
       -Tension: Asl,ten = 1746.726
     -Compression: Asl,com = 829.3805
        -Middle: Asl,mid = 1545.664

Calculation of Shear Capacity ratio , Ve/Vr = 0.66001051
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 279996.052
with
Mpr1 = Max(Mu1+ , Mu1-) = 4.1999E+008
  Mu1+ = 4.1999E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
  Mu1- = 2.3955E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 4.1999E+008
  Mu2+ = 4.1999E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
  Mu2- = 2.3955E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:

u = 1.3683047E-005

Mu = 4.1999E+008

----

with full section properties:

b = 250.00

d = 557.00

d' = 43.00

v = 0.0031899

  N = 8883.864

fc = 20.00

 co (5A.5, TBDY) = 0.002

Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077

  The Shear_factor is considered equal to 1 (pure moment strength)

  From (5.4b), TBDY: cu = 0.00768077

   we (5.4c) = 0.01092426

   ase = Max((($A_{conf,max}$-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783

    The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization

    of the rectangular sections confinement, which is expressed by (5.4d).

    The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)

    "Theoretical Stress-Strain Model for Confined Concrete."

    J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.

    Aconf,max = 169100.00 is the confined core area at levels of member with hoops and

      is calculated as the area of core enclosed by the center lines of the perimeter hoops.

    Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and

      is calculated by reducing all the dimensions of the area Aconf,max by a length

      equal to half the clear spacing between hoops.

    AnoConf = 105733.333 is the unconfined core area which is equal to bi2/6 as defined at (A.2).

   psh,min = Min(psh,x , psh,y) = 0.00482813

  Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

    ----

    psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813

     Lstir (Length of stirrups along Y) = 1460.00

     Astir (stirrups area) = 78.53982

     Asec (section area) = 237500.00

    ----

    psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813

     Lstir (Length of stirrups along X) = 1460.00

     Astir (stirrups area) = 78.53982

     Asec (section area) = 237500.00

    ----

     s = 100.00

     fywe = 555.55

     fce = 20.00

   From ((5.A5), TBDY), TBDY: cc = 0.002

     c = confinement factor = 1.00

 y1 = 0.00129669

 sh1 = 0.0044814

ft1 = 373.4467

fy1 = 311.2056

 su1 = 0.00512

  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

  and also multiplied by the shear_factor according to 15.7.1.4, with

  Shear_factor = 1.00

  lo/lou,min = lb/ld = 0.30

  su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

  From table 5A.1, TBDY: esu1_nominal = 0.08,

  For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered

  characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.

   with fs1 = fs = 311.2056

   with Es1 = Es = 200000.00

 y2 = 0.00129669

 sh2 = 0.0044814

ft2 = 373.4467

fy2 = 311.2056

 su2 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
  su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
  with fs2 = fs = 311.2056
  with Es2 = Es = 200000.00
 yv = 0.00129669
 shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
 suv = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esuv_nominal = 0.08,
  considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
  For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
  characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
    with fsv = fs = 311.2056
    with Esv = Es = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.19518516
  2 = Asl,com/(b*d)*(fs2/fc) = 0.09267785
  v = Asl,mid/(b*d)*(fsv/fc) = 0.17271781
and confined core properties:
  b = 190.00
  d = 527.00
  d' = 13.00
  fcc (5A.2, TBDY) = 20.00
   cc (5A.5, TBDY) = 0.002
      c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.27144246
    2 = Asl,com/(b*d)*(fs2/fc) = 0.12888635
    v = Asl,mid/(b*d)*(fsv/fc) = 0.24019729
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
 su (4.8) = 0.32821245
Mu = MRc (4.15) = 4.1999E+008
 u =   su (4.1) = 1.3683047E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.0987588E-005
Mu = 2.3955E+008
----

with full section properties:
   b = 600.00
   d = 557.00
   d' = 43.00
   v = 0.00132912
      N = 8883.864
   fc = 20.00
    co (5A.5, TBDY) = 0.002
   Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
      The Shear_factor is considered equal to 1 (pure moment strength)
      From (5.4b), TBDY: cu = 0.00768077
         we (5.4c) = 0.01092426
         ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
            The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
            of the rectangular sections confinement, which is expressed by (5.4d).
            The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
            "Theoretical Stress-Strain Model for Confined Concrete."
            J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
            Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
                  is calculated as the area of core enclosed by the center lines of the perimeter hoops.
            Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
                  is calculated by reducing all the dimensions of the area Aconf,max by a length
                  equal to half the clear spacing between hoops.
            AnoConf = 105733.333 is the unconfined core area which is equal to bi2/6 as defined at (A.2).
         psh,min = Min(psh,x , psh,y) = 0.00482813
      Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
         ----
         psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
            Lstir (Length of stirrups along Y) = 1460.00
            Astir (stirrups area) = 78.53982
            Asec (section area) = 237500.00
         ----
         psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
            Lstir (Length of stirrups along X) = 1460.00
            Astir (stirrups area) = 78.53982
            Asec (section area) = 237500.00
         ----
            s = 100.00
         fywe = 555.55
         fce = 20.00
      From ((5A5), TBDY), TBDY: cc = 0.002
          c = confinement factor = 1.00
   y1 = 0.00129669
   sh1 = 0.0044814
  ft1 = 373.4467
  fy1 = 311.2056
   su1 = 0.00512
      using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
      and also multiplied by the shear_factor according to 15.7.1.4, with
      Shear_factor = 1.00
      lo/lou,min = lb/ld = 0.30
       su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
      From table 5A.1, TBDY: esu1_nominal = 0.08,
      For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
      characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
       y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
       with fs1 = fs = 311.2056
       with Es1 = Es = 200000.00
   y2 = 0.00129669
   sh2 = 0.0044814
  ft2 = 373.4467
  fy2 = 311.2056
   su2 = 0.00512
      using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
      and also multiplied by the shear_factor according to 15.7.1.4, with
      Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.30
  su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
  with fs2 = fs = 311.2056
  with Es2 = Es = 200000.00
 yv = 0.00129669
 shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
 suv = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
   suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esuv_nominal = 0.08,
  considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
  For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
  characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
   y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
   with fsv = fs = 311.2056
   with Esv = Es = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.03861577
  2 = Asl,com/(b*d)*(fs2/fc) = 0.08132715
  v = Asl,mid/(b*d)*(fsv/fc) = 0.07196575
and confined core properties:
  b = 540.00
  d = 527.00
  d' = 13.00
 fcc (5A.2, TBDY) = 20.00
  cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.0453489
  2 = Asl,com/(b*d)*(fs2/fc) = 0.09550753
  v = Asl,mid/(b*d)*(fsv/fc) = 0.08451386
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.16341054
Mu = MRc (4.14) = 2.3955E+008
  u = su (4.1) = 1.0987588E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
 u = 1.3683047E-005
Mu = 4.1999E+008
----
with full section properties:
  b = 250.00
  d = 557.00
  d' = 43.00
  v = 0.0031899

```
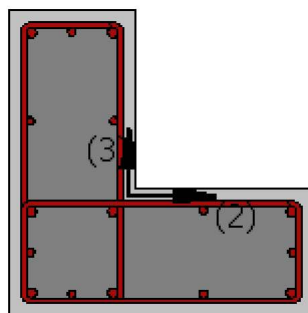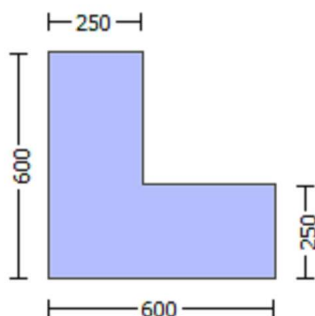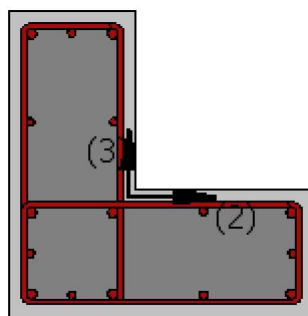        N = 8883.864
    fc = 20.00
      co (5A.5, TBDY) = 0.002
    Final value of  cu:  cu* = shear_factor * Max( cu,  cc) = 0.00768077
        The Shear_factor is considered equal to 1 (pure moment strength)
        From (5.4b), TBDY:  cu = 0.00768077
          we (5.4c) = 0.01092426
            ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
                The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
                of the rectangular sections confinement, which is expressed by (5.4d).
                The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
                "Theoretical Stress-Strain Model for Confined Concrete."
                J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
                Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
                        is calculated as the area of core enclosed by the center lines of the perimeter hoops.
                Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
                        is calculated by reducing all the dimensions of the area Aconf,max by a length
                        equal to half the clear spacing between hoops.
                AnoConf = 105733.333 is the unconfined core area which is equal to  bi2/6 as defined at (A.2).
            psh,min = Min(psh,x , psh,y) = 0.00482813
        Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
    earthquake detailing (90° closed stirrups)
            ----------------------------------------------------------------
            psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
                Lstir (Length of stirrups along Y) = 1460.00
                Astir (stirrups area) = 78.53982
                Asec (section area) = 237500.00
            ----------------------------------------------------------------
            psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
                Lstir (Length of stirrups along X) = 1460.00
                Astir (stirrups area) = 78.53982
                Asec (section area) = 237500.00
            ----------------------------------------------------------------
                s = 100.00
            fywe = 555.55
            fce = 20.00
        From ((5.A5), TBDY), TBDY:  cc = 0.002
            c  = confinement factor = 1.00
      y1 = 0.00129669
     sh1 = 0.0044814
    ft1 = 373.4467
    fy1 = 311.2056
     su1 = 0.00512
        using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
        and also multiplied by the shear_factor according to 15.7.1.4, with
        Shear_factor = 1.00
        lo/lou,min = lb/ld = 0.30
         su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
        From table 5A.1, TBDY: esu1_nominal = 0.08,
        For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
        characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
         y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
         with fs1 = fs = 311.2056
         with Es1 = Es = 200000.00
      y2 = 0.00129669
     sh2 = 0.0044814
    ft2 = 373.4467
    fy2 = 311.2056
     su2 = 0.00512
        using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
        and also multiplied by the shear_factor according to 15.7.1.4, with
        Shear_factor = 1.00
        lo/lou,min = lb/lb,min = 0.30
         su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
        From table 5A.1, TBDY: esu2_nominal = 0.08,
        For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
        characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
```

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE41-17.
   with fs2 = fs = 311.2056
   with Es2 = Es = 200000.00
yv = 0.00129669
shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
suv = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
   suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esuv_nominal = 0.08,
  considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
  For calculation of esuv_nominal and   yv, shv,ftv,fyv, it is considered
  characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE41-17.
  with fsv = fs = 311.2056
  with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.19518516
2 = Asl,com/(b*d)*(fs2/fc) = 0.09267785
v = Asl,mid/(b*d)*(fsv/fc) = 0.17271781
and confined core properties:
  b = 190.00
  d = 527.00
  d' = 13.00
  fcc (5A.2, TBDY) = 20.00
  cc (5A.5, TBDY) = 0.002
   c = confinement factor = 1.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.27144246
  2 = Asl,com/(b*d)*(fs2/fc) = 0.12888635
  v = Asl,mid/(b*d)*(fsv/fc) = 0.24019729
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.8) = 0.32821245
Mu = MRc (4.15) = 4.1999E+008
u =   su (4.1) = 1.3683047E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.0987588E-005
Mu = 2.3955E+008
----
with full section properties:
  b = 600.00
  d = 557.00
  d' = 43.00
  v = 0.00132912
   N = 8883.864
  fc = 20.00
  co (5A.5, TBDY) = 0.002

Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
   The Shear_factor is considered equal to 1 (pure moment strength)
   From (5.4b), TBDY: cu = 0.00768077
    we (5.4c) = 0.01092426
    ase = Max((($A_{conf,max}$-AnoConf)/$A_{conf,max}$)*($A_{conf,min}$/$A_{conf,max}$),0) = 0.27151783
      The definitions of AnoConf, $A_{conf,min}$ and $A_{conf,max}$ are derived from generalization
      of the rectangular sections confinement, which is expressed by (5.4d).
      The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
      "Theoretical Stress-Strain Model for Confined Concrete."
      J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
      $A_{conf,max}$ = 169100.00 is the confined core area at levels of member with hoops and
         is calculated as the area of core enclosed by the center lines of the perimeter hoops.
      $A_{conf,min}$ = 122525.00 is the confined core area at midway between the levels of hoops and
         is calculated by reducing all the dimensions of the area $A_{conf,max}$ by a length
         equal to half the clear spacing between hoops.
     AnoConf = 105733.333 is the unconfined core area which is equal to $bi2/6$ as defined at (A.2).
    psh,min = Min(psh,x , psh,y) = 0.00482813
   Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
    ----
    psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
     Lstir (Length of stirrups along Y) = 1460.00
     Astir (stirrups area) = 78.53982
     Asec (section area) = 237500.00
    ----
    psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
     Lstir (Length of stirrups along X) = 1460.00
     Astir (stirrups area) = 78.53982
     Asec (section area) = 237500.00
    ----
     s = 100.00
    fywe = 555.55
    fce = 20.00
   From ((5.A5), TBDY), TBDY: cc = 0.002
    c = confinement factor = 1.00
 y1 = 0.00129669
 sh1 = 0.0044814
ft1 = 373.4467
fy1 = 311.2056
 su1 = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
  su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esu1_nominal = 0.08,
  For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
  characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
  with fs1 = fs = 311.2056
  with Es1 = Es = 200000.00
 y2 = 0.00129669
 sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
 su2 = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/lb,min = 0.30
  su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esu2_nominal = 0.08,
  For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
  characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
  with fs2 = fs = 311.2056
  with Es2 = Es = 200000.00

yv = 0.00129669
shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
suv = 0.00512
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 lo/lou,min = lb/ld = 0.30
 suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
 From table 5A.1, TBDY: esuv_nominal = 0.08,
 considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
 For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
 characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
 y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
 with fsv = fs = 311.2056
 with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.03861577
2 = Asl,com/(b*d)*(fs2/fc) = 0.08132715
v = Asl,mid/(b*d)*(fsv/fc) = 0.07196575
and confined core properties:
b = 540.00
d = 527.00
d' = 13.00
fcc (5A.2, TBDY) = 20.00
cc (5A.5, TBDY) = 0.002
 c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0453489
2 = Asl,com/(b*d)*(fs2/fc) = 0.09550753
v = Asl,mid/(b*d)*(fsv/fc) = 0.08451386
Case/Assumption: Unconfinesd full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.16341054
Mu = MRc (4.14) = 2.3955E+008
u = su (4.1) = 1.0987588E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 424229.688

Calculation of Shear Strength at edge 1, Vr1 = 424229.688
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
 VCol0 = 424229.688
 knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

 = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 4.00
 Mu = 47.14131
 Vu = 0.00016213
d = 0.8*h = 480.00
Nu = 8883.864
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 474724.809
where:

Vs1 = 335099.865 is calculated for section web, with:
   d = 480.00
   Av = 157079.633
   fy = 444.44
   s = 100.00
Vs1 is multiplied by Col1 = 1.00
   s/d = 0.20833333
Vs2 = 139624.944 is calculated for section flange, with:
   d = 200.00
   Av = 157079.633
   fy = 444.44
   s = 100.00
Vs2 is multiplied by Col2 = 1.00
   s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 356502.845
   bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 424229.688
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 424229.688
  knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

   = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 4.00
   Mu = 47.14134
   Vu = 0.00016213
d = 0.8*h = 480.00
Nu = 8883.864
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 474724.809
where:
Vs1 = 335099.865 is calculated for section web, with:
   d = 480.00
   Av = 157079.633
   fy = 444.44
   s = 100.00
Vs1 is multiplied by Col1 = 1.00
   s/d = 0.20833333
Vs2 = 139624.944 is calculated for section flange, with:
   d = 200.00
   Av = 157079.633
   fy = 444.44
   s = 100.00
Vs2 is multiplied by Col2 = 1.00
   s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 356502.845
   bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rclcs

Constant Properties

Knowledge Factor, = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55
##
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = 0.00016213
EDGE -B-
Shear Force, Vb = -0.00016213
BOTH EDGES
Axial Force, F = -8883.864
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 4121.77
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1746.726
     -Compression: Asl,com = 829.3805
        -Middle: Asl,mid = 1545.664

Calculation of Shear Capacity ratio , Ve/Vr = 0.66001051
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 279996.052
with
Mpr1 = Max(Mu1+ , Mu1-) = 4.1999E+008
  Mu1+ = 4.1999E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
  Mu1- = 2.3955E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 4.1999E+008
  Mu2+ = 4.1999E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
  Mu2- = 2.3955E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination

----
Calculation of Mu1+

```
------------------------------------------------------------------------

------------------------------------------------------------------------
Calculation of ultimate curvature  φu according to 4.1, Biskinis/Fardis 2013:
  φu = 1.3683047E-005
Mu = 4.1999E+008
------------------------------------------------------------------------
with full section properties:
  b = 250.00
  d = 557.00
  d' = 43.00
  v = 0.0031899
     N = 8883.864
  fc = 20.00
   εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.00768077
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: εcu = 0.00768077
        ωwe (5.4c) = 0.01092426
        αse = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
           The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
           of the rectangular sections confinement, which is expressed by (5.4d).
           The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
           "Theoretical Stress-Strain Model for Confined Concrete."
           J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
           Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
                   is calculated as the area of core enclosed by the center lines of the perimeter hoops.
           Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
                   is calculated by reducing all the dimensions of the area Aconf,max by a length
                   equal to half the clear spacing between hoops.
           AnoConf = 105733.333 is the unconfined core area which is equal to Σbi²/6 as defined at (A.2).
        psh,min = Min(psh,x , psh,y) = 0.00482813
     Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
        ------------------------------------------------------------------
        psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
           Lstir (Length of stirrups along Y) = 1460.00
           Astir (stirrups area) = 78.53982
           Asec (section area) = 237500.00
        ------------------------------------------------------------------
        psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
           Lstir (Length of stirrups along X) = 1460.00
           Astir (stirrups area) = 78.53982
           Asec (section area) = 237500.00
        ------------------------------------------------------------------
           s = 100.00
         fywe = 555.55
         fce  = 20.00
     From ((5.A5), TBDY), TBDY: εcc = 0.002
         αc = confinement factor = 1.00
  εy1 = 0.00129669
  εsh1 = 0.0044814
  ft1 = 373.4467
  fy1 = 311.2056
   εsu1 = 0.00512
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/ld = 0.30
      εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esu1_nominal = 0.08,
     For calculation of esu1_nominal and εy1, εsh1,ft1,fy1, it is considered
     characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
      εy1, εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
      with fs1 = fs = 311.2056
      with Es1 = Es = 200000.00
  εy2 = 0.00129669
```

```
   sh2 = 0.0044814
  ft2 = 373.4467
  fy2 = 311.2056
   su2 = 0.00512
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/lb,min = 0.30
      su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esu2_nominal = 0.08,
     For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
     characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
      with fs2 = fs = 311.2056
      with Es2 = Es = 200000.00
   yv = 0.00129669
   shv = 0.0044814
  ftv = 373.4467
 fyv = 311.2056
   suv = 0.00512
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/ld = 0.30
      suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esuv_nominal = 0.08,
     considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
     For calculation of esuv_nominal and  yv, shv,ftv,fyv, it is considered
     characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
      with fsv = fs = 311.2056
      with Esv = Es = 200000.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.19518516
   2 = Asl,com/(b*d)*(fs2/fc) = 0.09267785
   v = Asl,mid/(b*d)*(fsv/fc) = 0.17271781
and confined core properties:
  b = 190.00
  d = 527.00
  d' = 13.00
  fcc (5A.2, TBDY) = 20.00
   cc (5A.5, TBDY) = 0.002
     c  = confinement factor = 1.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.27144246
   2 = Asl,com/(b*d)*(fs2/fc) = 0.12888635
   v = Asl,mid/(b*d)*(fsv/fc) = 0.24019729
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
 su (4.8) = 0.32821245
Mu = MRc (4.15) = 4.1999E+008
  u =   su (4.1) = 1.3683047E-005
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
--------------------------------------------------------------------
--------------------------------------------------------------------
--------------------------------------------------------------------
Calculation of Mu1-
--------------------------------------------------------------------

--------------------------------------------------------------------
```

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 1.0987588E-005
Mu = 2.3955E+008
----
with full section properties:
  b = 600.00
  d = 557.00
  d' = 43.00
  v = 0.00132912
    N = 8883.864
  fc = 20.00
   εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.00768077
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.00768077
      ωwe (5.4c) = 0.01092426
      αse = Max((((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
          The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
          of the rectangular sections confinement, which is expressed by (5.4d).
          The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
          "Theoretical Stress-Strain Model for Confined Concrete."
          J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
          Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
                is calculated as the area of core enclosed by the center lines of the perimeter hoops.
          Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
                is calculated by reducing all the dimensions of the area Aconf,max by a length
                equal to half the clear spacing between hoops.
          AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
      ρsh,min = Min(ρsh,x , ρsh,y) = 0.00482813
    Expression ((5.4d), TBDY) for ρsh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

        ρsh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
          Lstir (Length of stirrups along Y) = 1460.00
          Astir (stirrups area) = 78.53982
          Asec (section area) = 237500.00

        ρsh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
          Lstir (Length of stirrups along X) = 1460.00
          Astir (stirrups area) = 78.53982
          Asec (section area) = 237500.00
      ----
          s = 100.00
          fywe = 555.55
          fce = 20.00
      From ((5.A5), TBDY), TBDY: εcc = 0.002
          εc = confinement factor = 1.00
  εy1 = 0.00129669
  εsh1 = 0.0044814
 ft1 = 373.4467
 fy1 = 311.2056
  εsu1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
     εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and εy1, εsh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
     εy1, εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
      with fs1 = fs = 311.2056
      with Es1 = Es = 200000.00
  εy2 = 0.00129669
  εsh2 = 0.0044814
 ft2 = 373.4467
 fy2 = 311.2056

su2 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/lb,min = 0.30
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esu2_nominal = 0.08,
   For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
   characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
    with fs2 = fs = 311.2056
    with Es2 = Es = 200000.00
  yv = 0.00129669
  shv = 0.0044814
 ftv = 373.4467
 fyv = 311.2056
  suv = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.30
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esuv_nominal = 0.08,
   considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
   For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
   characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
    with fsv = fs = 311.2056
    with Esv = Es = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.03861577
  2 = Asl,com/(b*d)*(fs2/fc) = 0.08132715
  v = Asl,mid/(b*d)*(fsv/fc) = 0.07196575
and confined core properties:
  b = 540.00
  d = 527.00
  d' = 13.00
  fcc (5A.2, TBDY) = 20.00
   cc (5A.5, TBDY) = 0.002
     c = confinement factor = 1.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.0453489
   2 = Asl,com/(b*d)*(fs2/fc) = 0.09550753
   v = Asl,mid/(b*d)*(fsv/fc) = 0.08451386
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.16341054
Mu = MRc (4.14) = 2.3955E+008
  u =   su (4.1) = 1.0987588E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.3683047E-005
Mu = 4.1999E+008
----
with full section properties:

b = 250.00
d = 557.00
d' = 43.00
ν = 0.0031899
  N = 8883.864
fc = 20.00
 co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
   The Shear_factor is considered equal to 1 (pure moment strength)
   From (5.4b), TBDY: cu = 0.00768077
     we (5.4c) = 0.01092426
     ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
               is calculated as the area of core enclosed by the center lines of the perimeter hoops.
        Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
               is calculated by reducing all the dimensions of the area Aconf,max by a length
               equal to half the clear spacing between hoops.
        AnoConf = 105733.333 is the unconfined core area which is equal to bi2/6 as defined at (A.2).
     psh,min = Min(psh,x , psh,y) = 0.00482813
   Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

     ----
     psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
        Lstir (Length of stirrups along Y) = 1460.00
        Astir (stirrups area) = 78.53982
        Asec (section area) = 237500.00
     ----
     psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
        Lstir (Length of stirrups along X) = 1460.00
        Astir (stirrups area) = 78.53982
        Asec (section area) = 237500.00
     ----
        s = 100.00
      fywe = 555.55
       fce = 20.00
   From ((5.A5), TBDY), TBDY: cc = 0.002
        c = confinement factor = 1.00
 y1 = 0.00129669
 sh1 = 0.0044814
ft1 = 373.4467
fy1 = 311.2056
 su1 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.30
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esu1_nominal = 0.08,
   For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
   characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE41-17.
    with fs1 = fs = 311.2056
    with Es1 = Es = 200000.00
 y2 = 0.00129669
 sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
 su2 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/lb,min = 0.30

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esu2_nominal = 0.08,
   For calculation of esu2_nominal and   y2, sh2,ft2,fy2, it is considered
   characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
    with fs2 = fs = 311.2056
    with Es2 = Es = 200000.00
  yv = 0.00129669
  shv = 0.0044814
 ftv = 373.4467
 fyv = 311.2056
  suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
     suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esuv_nominal = 0.08,
   considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
   For calculation of esuv_nominal and   yv, shv,ftv,fyv, it is considered
   characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
    with fsv = fs = 311.2056
    with Esv = Es = 200000.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.19518516
   2 = Asl,com/(b*d)*(fs2/fc) = 0.09267785
   v = Asl,mid/(b*d)*(fsv/fc) = 0.17271781
and confined core properties:
  b = 190.00
  d = 527.00
  d' = 13.00
  fcc (5A.2, TBDY) = 20.00
   cc (5A.5, TBDY) = 0.002
     c = confinement factor = 1.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.27144246
   2 = Asl,com/(b*d)*(fs2/fc) = 0.12888635
   v = Asl,mid/(b*d)*(fsv/fc) = 0.24019729
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
 su (4.8) = 0.32821245
Mu = MRc (4.15) = 4.1999E+008
  u =   su (4.1) = 1.3683047E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.0987588E-005
Mu = 2.3955E+008
----
with full section properties:
  b = 600.00
  d = 557.00
  d' = 43.00

v = 0.00132912
   N = 8883.864
fc = 20.00
  co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
   The Shear_factor is considered equal to 1 (pure moment strength)
   From (5.4b), TBDY: cu = 0.00768077
     we (5.4c) = 0.01092426
     ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
             is calculated as the area of core enclosed by the center lines of the perimeter hoops.
        Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
             is calculated by reducing all the dimensions of the area Aconf,max by a length
             equal to half the clear spacing between hoops.
        AnoConf = 105733.333 is the unconfined core area which is equal to bi2/6 as defined at (A.2).
     psh,min = Min(psh,x , psh,y) = 0.00482813
   Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

     ----
     psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
        Lstir (Length of stirrups along Y) = 1460.00
        Astir (stirrups area) = 78.53982
        Asec (section area) = 237500.00
     ----
     psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
        Lstir (Length of stirrups along X) = 1460.00
        Astir (stirrups area) = 78.53982
        Asec (section area) = 237500.00
     ----
        s = 100.00
        fywe = 555.55
        fce = 20.00
     From ((5.A5), TBDY), TBDY: cc = 0.002
        c = confinement factor = 1.00
  y1 = 0.00129669
  sh1 = 0.0044814
 ft1 = 373.4467
 fy1 = 311.2056
  su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
     su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
     with fs1 = fs = 311.2056
     with Es1 = Es = 200000.00
  y2 = 0.00129669
  sh2 = 0.0044814
 ft2 = 373.4467
 fy2 = 311.2056
  su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.30
     su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered

characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
    with fs2 = fs = 311.2056
    with Es2 = Es = 200000.00
 yv = 0.00129669
 shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
 suv = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.30
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esuv_nominal = 0.08,
   considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
   For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
   characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
     with fsv = fs = 311.2056
     with Esv = Es = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.03861577
  2 = Asl,com/(b*d)*(fs2/fc) = 0.08132715
  v = Asl,mid/(b*d)*(fsv/fc) = 0.07196575
and confined core properties:
  b = 540.00
  d = 527.00
  d' = 13.00
  fcc (5A.2, TBDY) = 20.00
   cc (5A.5, TBDY) = 0.002
     c = confinement factor = 1.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.0453489
   2 = Asl,com/(b*d)*(fs2/fc) = 0.09550753
   v = Asl,mid/(b*d)*(fsv/fc) = 0.08451386
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.16341054
Mu = MRc (4.14) = 2.3955E+008
 u =   su (4.1) = 1.0987588E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 424229.688

Calculation of Shear Strength at edge 1, Vr1 = 424229.688
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 424229.688
  knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

    = 1 (normal-weight concrete)
  fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
    Mu = 47.13723
    Vu = 0.00016213
  d = 0.8*h = 480.00

Nu = 8883.864
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 474724.809
where:
Vs1 = 139624.944 is calculated for section web, with:
   d = 200.00
   Av = 157079.633
   fy = 444.44
   s = 100.00
Vs1 is multiplied by   Col1 = 1.00
   s/d = 0.50
Vs2 = 335099.865 is calculated for section flange, with:
   d = 480.00
   Av = 157079.633
   fy = 444.44
   s = 100.00
Vs2 is multiplied by   Col2 = 1.00
   s/d = 0.20833333
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 356502.845
   bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 424229.688
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
   VCol0 = 424229.688
   knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

   = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 4.00
   Mu = 47.13721
   Vu = 0.00016213
d = 0.8*h = 480.00
Nu = 8883.864
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 474724.809
where:
Vs1 = 139624.944 is calculated for section web, with:
   d = 200.00
   Av = 157079.633
   fy = 444.44
   s = 100.00
Vs1 is multiplied by   Col1 = 1.00
   s/d = 0.50
Vs2 = 335099.865 is calculated for section flange, with:
   d = 480.00
   Av = 157079.633
   fy = 444.44
   s = 100.00
Vs2 is multiplied by   Col2 = 1.00
   s/d = 0.20833333
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 356502.845
   bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column LC1 of floor 1

At local axis: 2
Integration Section: (a)
Section Type: rclcs

Constant Properties

Knowledge Factor,   = 1.00
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lb/ld = 0.30
No FRP Wrapping

Stepwise Properties

Bending Moment, M = -262290.50
Shear Force, V2 = -3517.163
Shear Force, V3 = 121.1248
Axial Force, F = -9523.595
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
    -Compression: Aslc = 4121.77
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 1746.726
    -Compression: Asl,com = 829.3805
       -Middle: Asl,mid = 1545.664
Mean Diameter of Tension Reinforcement, DbL = 17.71429

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity u,R =   * u = 0.03452874
 u = y + p = 0.03452874

 - Calculation of y -
----
 y = (My*Ls/3)/Eleff = 0.00452874 ((4.29),Biskinis Phd))
 My = 2.6302E+008
 Ls = M/V (with Ls > 0.1*L and Ls < 2*L) = 2165.456
 From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 4.1921E+013
    factor = 0.30
       Ag = 237500.00
       fc' = 20.00
       N = 9523.595
    Ec*Ig = 1.3974E+014

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7 -
----
 y = Min(y_ten, y_com)
 y_ten = 3.6310943E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 248.9644
    d = 557.00
    y = 0.38451907
    A = 0.02987449
    B = 0.01925673
     with pt = 0.01254381
        pc = 0.00595605
        pv = 0.01109992
        N = 9523.595
        b = 250.00
        " = 0.07719928
  y_comp = 8.0244262E-006
 with fc = 20.00
    Ec = 21019.039
     y = 0.38319556
    A = 0.02940012
    B = 0.01898202
     with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

 - Calculation of p -

From table 10-8: p = 0.03
with:
 - Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
   shear control ratio VyE/VColOE = 0.66001051
   d = 557.00
   s = 0.00
    t = Av/(bw*s) + 2*tf/bw*(ffe/fs) = Av*Lstir/(Ag*s) + 2*tf/bw*(ffe/fs) = 0.00
   Av = 78.53982, is the area of every stirrup
   Lstir = 1460.00, is the total Length of all stirrups parallel to loading (shear) direction
   The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
   where f = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises f to steel strength
   All these variables have already been given in Shear control ratio calculation.
   NUD = 9523.595
   Ag = 237500.00
   f'cE = 20.00
   fytE = fylE = 0.00
pl = Area_Tot_Long_Rein/(b*d) = 0.02959978
  b = 250.00
  d = 557.00
   f'cE = 20.00

End Of Calculation of Chord Rotation Capacity for element: column LC1 of floor 1
At local axis: 2
Integration Section: (a)

Calculation No. 11

column C1, Floor 1

Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (3)

Start Of Calculation of Shear Capacity for element: column LC1 of floor 1
At local axis: 3
Integration Section: (a)
Section Type: rclcs

Constant Properties

Knowledge Factor,   = 1.00
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of y for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE41-17).
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.44
##
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = lb/ld = 0.30
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -262290.50
Shear Force, Va = 121.1248
EDGE -B-
Bending Moment, Mb = -99752.057
Shear Force, Vb = -121.1248
BOTH EDGES
Axial Force, F = -9523.595
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 4121.77
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1746.726
     -Compression: Asl,com = 829.3805
        -Middle: Asl,mid = 1545.664
Mean Diameter of Tension Reinforcement, DbL,ten = 17.71429

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR =   *Vn = 379598.075
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 379598.075
   VCol = 379598.075
   knl = 1.00
      displacement_ductility_demand = 0.00865316

NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

    = 1 (normal-weight concrete)
 fc' = 16.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
 M/Vd = 4.00
    Mu = 262290.50
    Vu = 121.1248
 d = 0.8*h = 480.00
 Nu = 9523.595
 Ag = 150000.00
 From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 427256.601
 where:
 Vs1 = 301592.895 is calculated for section web, with:
    d = 480.00
    Av = 157079.633
    fy = 400.00
    s = 100.00
 Vs1 is multiplied by Col1 = 1.00
    s/d = 0.20833333
 Vs2 = 125663.706 is calculated for section flange, with:
    d = 200.00
    Av = 157079.633
    fy = 400.00
    s = 100.00
 Vs2 is multiplied by Col2 = 1.00
    s/d = 0.50
 Vf ((11-3)-(11.4), ACI 440) = 0.00
 From (11-11), ACI 440: Vs + Vf <= 318865.838
    bw = 250.00

----
displacement_ductility_demand is calculated as   / y

- Calculation of / y for END A -
 for rotation axis 2 and integ. section (a)

From analysis, chord rotation   = 3.9187927E-005
  y = (My*Ls/3)/Eleff = 0.00452874 ((4.29),Biskinis Phd))
   My = 2.6302E+008
   Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 2165.456
   From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 4.1921E+013
      factor = 0.30
         Ag = 237500.00
         fc' = 20.00
         N = 9523.595
      Ec*Ig = 1.3974E+014

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7   -
----
  y = Min(y_ten, y_com)
  y_ten = 3.6310943E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 248.9644
    d = 557.00
     y = 0.38451907
    A = 0.02987449
    B = 0.01925673
     with pt = 0.01254381
        pc = 0.00595605
        pv = 0.01109992
        N = 9523.595
        b = 250.00
        " = 0.07719928
  y_comp = 8.0244262E-006
 with fc = 20.00
     Ec = 21019.039
      y = 0.38319556
     A = 0.02940012
     B = 0.01898202
      with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

End Of Calculation of Shear Capacity for element: column LC1 of floor 1
At local axis: 3
Integration Section: (a)

Calculation No. 12

column C1, Floor 1

Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: Start

Local Axis: (3)

Start Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rclcs

Constant Properties

Knowledge Factor, = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55
##
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-

Shear Force, Va = 0.00016213
EDGE -B-
Shear Force, Vb = -0.00016213
BOTH EDGES
Axial Force, F = -8883.864
Longitudinal Reinforcement Area Distribution (in 2 divisions)
    -Tension: Aslt = 0.00
  -Compression: Aslc = 4121.77
Longitudinal Reinforcement Area Distribution (in 3 divisions)
    -Tension: Asl,ten = 1746.726
  -Compression: Asl,com = 829.3805
    -Middle: Asl,mid = 1545.664

Calculation of Shear Capacity ratio , Ve/Vr = 0.66001051
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 279996.052
with
Mpr1 = Max(Mu1+ , Mu1-) = 4.1999E+008
  Mu1+ = 4.1999E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
  Mu1- = 2.3955E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 4.1999E+008
  Mu2+ = 4.1999E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
  Mu2- = 2.3955E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.3683047E-005
Mu = 4.1999E+008
----
with full section properties:
  b = 250.00
  d = 557.00
  d' = 43.00
  v = 0.0031899
    N = 8883.864
  fc = 20.00
   co (5A.5, TBDY) = 0.002
  Final value of   cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00768077
      we (5.4c) = 0.01092426
      ase = Max((($Aconf,max-AnoConf)/Aconf,max$)*($Aconf,min/Aconf,max$),0) = 0.27151783
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
              is calculated as the area of core enclosed by the center lines of the perimeter hoops.
        Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
              is calculated by reducing all the dimensions of the area Aconf,max by a length
              equal to half the clear spacing between hoops.
        AnoConf = 105733.333 is the unconfined core area which is equal to   bi2/6 as defined at (A.2).
      psh,min = Min(psh,x , psh,y) = 0.00482813
    Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

```
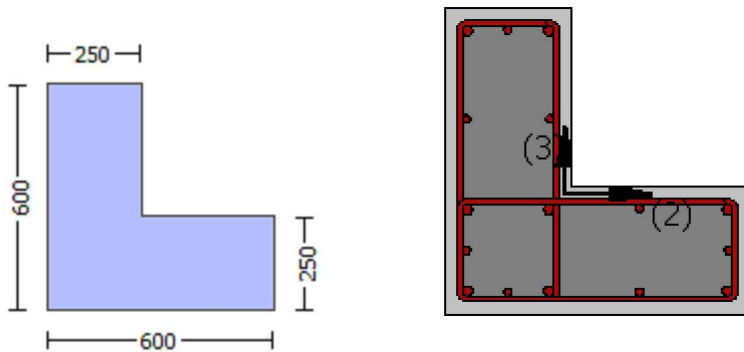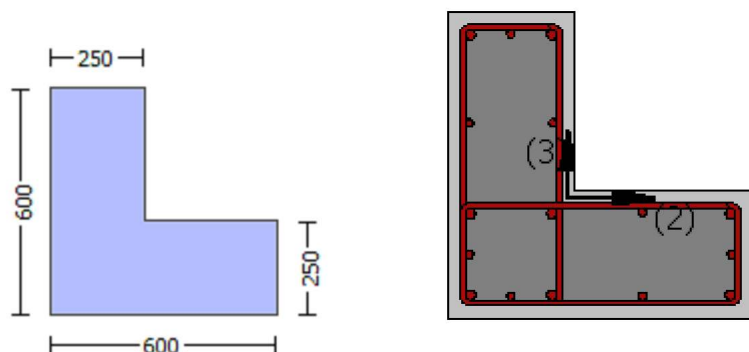-----------------------------------------------------------------
   psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
      Lstir (Length of stirrups along Y) = 1460.00
      Astir (stirrups area) = 78.53982
      Asec (section area) = 237500.00
-----------------------------------------------------------------
   psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
      Lstir (Length of stirrups along X) = 1460.00
      Astir (stirrups area) = 78.53982
      Asec (section area) = 237500.00
-----------------------------------------------------------------
      s = 100.00
    fywe = 555.55
    fce  = 20.00
  From ((5.A5), TBDY), TBDY:  cc = 0.002
      c = confinement factor = 1.00
 y1 = 0.00129669
 sh1 = 0.0044814
ft1 = 373.4467
fy1 = 311.2056
 su1 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.30
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esu1_nominal = 0.08,
   For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
   characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
    with fs1 = fs = 311.2056
    with Es1 = Es = 200000.00
 y2 = 0.00129669
 sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
 su2 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/lb,min = 0.30
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esu2_nominal = 0.08,
   For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
   characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
    with fs2 = fs = 311.2056
    with Es2 = Es = 200000.00
 yv = 0.00129669
 shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
 suv = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.30
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esuv_nominal = 0.08,
   considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
   For calculation of esuv_nominal and  yv, shv,ftv,fyv, it is considered
   characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
    with fsv = fs = 311.2056
    with Esv = Es = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.19518516
  2 = Asl,com/(b*d)*(fs2/fc) = 0.09267785
```

v = Asl,mid/(b*d)*(fsv/fc) = 0.17271781
and confined core properties:
   b = 190.00
   d = 527.00
   d' = 13.00
   fcc (5A.2, TBDY) = 20.00
    cc (5A.5, TBDY) = 0.002
       c = confinement factor = 1.00
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.27144246
     2 = Asl,com/(b*d)*(fs2/fc) = 0.12888635
       v = Asl,mid/(b*d)*(fsv/fc) = 0.24019729
Case/Assumption: Unconfinesd full section - Steel rupture
   ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
   su (4.8) = 0.32821245
Mu = MRc (4.15) = 4.1999E+008
   u =   su (4.1) = 1.3683047E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
   u = 1.0987588E-005
Mu = 2.3955E+008
----
with full section properties:
   b = 600.00
   d = 557.00
   d' = 43.00
   v = 0.00132912
     N = 8883.864
   fc = 20.00
    co (5A.5, TBDY) = 0.002
   Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
      The Shear_factor is considered equal to 1 (pure moment strength)
      From (5.4b), TBDY: cu = 0.00768077
        we (5.4c) = 0.01092426
        ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
           The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
           of the rectangular sections confinement, which is expressed by (5.4d).
           The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
           "Theoretical Stress-Strain Model for Confined Concrete."
           J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
           Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
                   is calculated as the area of core enclosed by the center lines of the perimeter hoops.
           Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
                   is calculated by reducing all the dimensions of the area Aconf,max by a length
                   equal to half the clear spacing between hoops.
           AnoConf = 105733.333 is the unconfined core area which is equal to   bi2/6 as defined at (A.2).
        psh,min = Min(psh,x , psh,y) = 0.00482813
      Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
        ----
           psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
             Lstir (Length of stirrups along Y) = 1460.00

135

Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 555.55
fce = 20.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00129669
sh1 = 0.0044814
ft1 = 373.4467
fy1 = 311.2056
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 311.2056
with Es1 = Es = 200000.00
y2 = 0.00129669
sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 311.2056
with Es2 = Es = 200000.00
yv = 0.00129669
shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 311.2056
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.03861577
2 = Asl,com/(b*d)*(fs2/fc) = 0.08132715
v = Asl,mid/(b*d)*(fsv/fc) = 0.07196575
and confined core properties:
b = 540.00

d = 527.00
d' = 13.00
fcc (5A.2, TBDY) = 20.00
  cc (5A.5, TBDY) = 0.002
      c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.0453489
    2 = Asl,com/(b*d)*(fs2/fc) = 0.09550753
    v = Asl,mid/(b*d)*(fsv/fc) = 0.08451386
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.16341054
Mu = MRc (4.14) = 2.3955E+008
  u =   su (4.1) = 1.0987588E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.3683047E-005
Mu = 4.1999E+008
----
with full section properties:
  b = 250.00
  d = 557.00
  d' = 43.00
  v = 0.0031899
    N = 8883.864
  fc = 20.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00768077
      we (5.4c) = 0.01092426
      ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
          The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
          of the rectangular sections confinement, which is expressed by (5.4d).
          The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
          "Theoretical Stress-Strain Model for Confined Concrete."
          J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
          Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
                  is calculated as the area of core enclosed by the center lines of the perimeter hoops.
          Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
                  is calculated by reducing all the dimensions of the area Aconf,max by a length
                  equal to half the clear spacing between hoops.
          AnoConf = 105733.333 is the unconfined core area which is equal to   bi2/6 as defined at (A.2).
        psh,min = Min(psh,x , psh,y) = 0.00482813
      Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
        ----
        psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
            Lstir (Length of stirrups along Y) = 1460.00
            Astir (stirrups area) = 78.53982
            Asec (section area) = 237500.00
        ----
        psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
            Lstir (Length of stirrups along X) = 1460.00

```
        Astir (stirrups area) = 78.53982
        Asec (section area) = 237500.00
   -----------------------------------------------------------------
          s = 100.00
       fywe = 555.55
        fce = 20.00
     From ((5.A5), TBDY), TBDY:  cc = 0.002
          c = confinement factor = 1.00
   y1 = 0.00129669
  sh1 = 0.0044814
 ft1 = 373.4467
 fy1 = 311.2056
  su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
     su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
      with fs1 = fs = 311.2056
      with Es1 = Es = 200000.00
   y2 = 0.00129669
  sh2 = 0.0044814
 ft2 = 373.4467
 fy2 = 311.2056
  su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.30
     su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
      with fs2 = fs = 311.2056
      with Es2 = Es = 200000.00
   yv = 0.00129669
  shv = 0.0044814
 ftv = 373.4467
 fyv = 311.2056
  suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
     suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and  yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
      with fsv = fs = 311.2056
      with Esv = Es = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.19518516
    2 = Asl,com/(b*d)*(fs2/fc) = 0.09267785
    v = Asl,mid/(b*d)*(fsv/fc) = 0.17271781
 and confined core properties:
   b = 190.00
   d = 527.00
   d' = 13.00
   fcc (5A.2, TBDY) = 20.00
    cc (5A.5, TBDY) = 0.002
      c = confinement factor = 1.00
```

1 = Asl,ten/(b*d)*(fs1/fc) = 0.27144246
        2 = Asl,com/(b*d)*(fs2/fc) = 0.12888635
        v = Asl,mid/(b*d)*(fsv/fc) = 0.24019729
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
 su (4.8) = 0.32821245
Mu = MRc (4.15) = 4.1999E+008
  u =   su (4.1) = 1.3683047E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.0987588E-005
Mu = 2.3955E+008
----
with full section properties:
  b = 600.00
  d = 557.00
  d' = 43.00
  v = 0.00132912
    N = 8883.864
  fc = 20.00
   co (5A.5, TBDY) = 0.002
  Final value of   cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: cu = 0.00768077
       we (5.4c) = 0.01092426
       ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
          The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
          of the rectangular sections confinement, which is expressed by (5.4d).
          The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
          "Theoretical Stress-Strain Model for Confined Concrete."
          J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
          Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
                  is calculated as the area of core enclosed by the center lines of the perimeter hoops.
          Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
                  is calculated by reducing all the dimensions of the area Aconf,max by a length
                  equal to half the clear spacing between hoops.
          AnoConf = 105733.333 is the unconfined core area which is equal to   bi2/6 as defined at (A.2).
       psh,min = Min(psh,x , psh,y) = 0.00482813
     Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
       ----
       psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
          Lstir (Length of stirrups along Y) = 1460.00
          Astir (stirrups area) = 78.53982
          Asec (section area) = 237500.00
       ----
       psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
          Lstir (Length of stirrups along X) = 1460.00
          Astir (stirrups area) = 78.53982
          Asec (section area) = 237500.00

```
        s = 100.00
     fywe = 555.55
      fce = 20.00
   From ((5.A5), TBDY), TBDY:  cc = 0.002
       c = confinement factor = 1.00
  y1 = 0.00129669
  sh1 = 0.0044814
 ft1 = 373.4467
 fy1 = 311.2056
  su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
     su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
     with fs1 = fs = 311.2056
     with Es1 = Es = 200000.00
  y2 = 0.00129669
  sh2 = 0.0044814
 ft2 = 373.4467
 fy2 = 311.2056
  su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.30
     su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
     with fs2 = fs = 311.2056
     with Es2 = Es = 200000.00
  yv = 0.00129669
  shv = 0.0044814
 ftv = 373.4467
 fyv = 311.2056
  suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
     suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and  yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
     with fsv = fs = 311.2056
     with Esv = Es = 200000.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.03861577
   2 = Asl,com/(b*d)*(fs2/fc) = 0.08132715
   v = Asl,mid/(b*d)*(fsv/fc) = 0.07196575
 and confined core properties:
  b = 540.00
  d = 527.00
  d' = 13.00
  fcc (5A.2, TBDY) = 20.00
   cc (5A.5, TBDY) = 0.002
       c = confinement factor = 1.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.0453489
   2 = Asl,com/(b*d)*(fs2/fc) = 0.09550753
   v = Asl,mid/(b*d)*(fsv/fc) = 0.08451386
```

Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.16341054
Mu = MRc (4.14) = 2.3955E+008
  u =   su (4.1) = 1.0987588E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 424229.688

Calculation of Shear Strength at edge 1, Vr1 = 424229.688
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 424229.688
  knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+   f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

    = 1 (normal-weight concrete)
  fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
    Mu = 47.14131
    Vu = 0.00016213
  d = 0.8*h = 480.00
  Nu = 8883.864
  Ag = 150000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 474724.809
  where:
  Vs1 = 335099.865 is calculated for section web, with:
    d = 480.00
    Av = 157079.633
    fy = 444.44
    s = 100.00
  Vs1 is multiplied by   Col1 = 1.00
    s/d = 0.20833333
  Vs2 = 139624.944 is calculated for section flange, with:
    d = 200.00
    Av = 157079.633
    fy = 444.44
    s = 100.00
  Vs2 is multiplied by   Col2 = 1.00
    s/d = 0.50
  Vf ((11-3)-(11.4), ACI 440) = 0.00
  From (11-11), ACI 440: Vs + Vf <= 356502.845
    bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 424229.688
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 424229.688
  knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+   f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

    = 1 (normal-weight concrete)
  fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00

Mu = 47.14134
Vu = 0.00016213
d = 0.8*h = 480.00
Nu = 8883.864
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 474724.809
where:
Vs1 = 335099.865 is calculated for section web, with:
  d = 480.00
  Av = 157079.633
  fy = 444.44
  s = 100.00
Vs1 is multiplied by   Col1 = 1.00
  s/d = 0.20833333
Vs2 = 139624.944 is calculated for section flange, with:
  d = 200.00
  Av = 157079.633
  fy = 444.44
  s = 100.00
Vs2 is multiplied by   Col2 = 1.00
  s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 356502.845
  bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rclcs

Constant Properties

Knowledge Factor,   = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55
##
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = 0.00016213
EDGE -B-
Shear Force, Vb = -0.00016213
BOTH EDGES
Axial Force, F = -8883.864
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
    -Compression: Aslc = 4121.77
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1746.726
    -Compression: Asl,com = 829.3805
        -Middle: Asl,mid = 1545.664

Calculation of Shear Capacity ratio , Ve/Vr = 0.66001051
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 279996.052
with
Mpr1 = Max(Mu1+ , Mu1-) = 4.1999E+008
   Mu1+ = 4.1999E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
   Mu1- = 2.3955E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 4.1999E+008
   Mu2+ = 4.1999E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
   Mu2- = 2.3955E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.3683047E-005
Mu = 4.1999E+008
----
with full section properties:
  b = 250.00
  d = 557.00
  d' = 43.00
  v = 0.0031899
    N = 8883.864
  fc = 20.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00768077
      we (5.4c) = 0.01092426
      ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
                is calculated as the area of core enclosed by the center lines of the perimeter hoops.
        Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
                is calculated by reducing all the dimensions of the area Aconf,max by a length
                equal to half the clear spacing between hoops.

AnoConf = 105733.333 is the unconfined core area which is equal to bi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00

----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00

----
s = 100.00
fywe = 555.55
fce = 20.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00129669
sh1 = 0.0044814
ft1 = 373.4467
fy1 = 311.2056
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 311.2056
with Es1 = Es = 200000.00
y2 = 0.00129669
sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 311.2056
with Es2 = Es = 200000.00
yv = 0.00129669
shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.

with fsv = fs = 311.2056
     with Esv = Es = 200000.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.19518516
   2 = Asl,com/(b*d)*(fs2/fc) = 0.09267785
   v = Asl,mid/(b*d)*(fsv/fc) = 0.17271781
and confined core properties:
  b = 190.00
  d = 527.00
  d' = 13.00
  fcc (5A.2, TBDY) = 20.00
   cc (5A.5, TBDY) = 0.002
      c = confinement factor = 1.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.27144246
   2 = Asl,com/(b*d)*(fs2/fc) = 0.12888635
   v = Asl,mid/(b*d)*(fsv/fc) = 0.24019729
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
 su (4.8) = 0.32821245
Mu = MRc (4.15) = 4.1999E+008
  u =   su (4.1) = 1.3683047E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.0987588E-005
Mu = 2.3955E+008
----
with full section properties:
  b = 600.00
  d = 557.00
  d' = 43.00
  v = 0.00132912
    N = 8883.864
  fc = 20.00
   co (5A.5, TBDY) = 0.002
  Final value of   cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00768077
      we (5.4c) = 0.01092426
       ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
          The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
          of the rectangular sections confinement, which is expressed by (5.4d).
          The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
          "Theoretical Stress-Strain Model for Confined Concrete."
          J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
          Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
                  is calculated as the area of core enclosed by the center lines of the perimeter hoops.
          Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
                  is calculated by reducing all the dimensions of the area Aconf,max by a length
                  equal to half the clear spacing between hoops.
          AnoConf = 105733.333 is the unconfined core area which is equal to   bi2/6 as defined at (A.2).
        psh,min = Min(psh,x , psh,y) = 0.00482813
     Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without

earthquake detailing (90° closed stirrups)
```
        ----------------------------------------------------------------
           psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
              Lstir (Length of stirrups along Y) = 1460.00
              Astir (stirrups area) = 78.53982
              Asec (section area) = 237500.00
        ----------------------------------------------------------------
           psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
              Lstir (Length of stirrups along X) = 1460.00
              Astir (stirrups area) = 78.53982
              Asec (section area) = 237500.00
        ----------------------------------------------------------------
             s = 100.00
           fywe = 555.55
           fce  = 20.00
        From ((5.A5), TBDY), TBDY:  cc = 0.002
             c = confinement factor = 1.00
      y1 = 0.00129669
     sh1 = 0.0044814
    ft1 = 373.4467
    fy1 = 311.2056
     su1 = 0.00512
        using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
        and also multiplied by the shear_factor according to 15.7.1.4, with
        Shear_factor = 1.00
        lo/lou,min = lb/ld = 0.30
          su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
        From table 5A.1, TBDY: esu1_nominal = 0.08,
        For calculation of esu1_nominal and   y1, sh1,ft1,fy1, it is considered
        characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
          y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
          with fs1 = fs = 311.2056
          with Es1 = Es = 200000.00
      y2 = 0.00129669
     sh2 = 0.0044814
    ft2 = 373.4467
    fy2 = 311.2056
     su2 = 0.00512
        using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
        and also multiplied by the shear_factor according to 15.7.1.4, with
        Shear_factor = 1.00
        lo/lou,min = lb/lb,min = 0.30
          su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
        From table 5A.1, TBDY: esu2_nominal = 0.08,
        For calculation of esu2_nominal and   y2, sh2,ft2,fy2, it is considered
        characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
          y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
          with fs2 = fs = 311.2056
          with Es2 = Es = 200000.00
      yv = 0.00129669
     shv = 0.0044814
    ftv = 373.4467
    fyv = 311.2056
     suv = 0.00512
        using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
        and also multiplied by the shear_factor according to 15.7.1.4, with
        Shear_factor = 1.00
        lo/lou,min = lb/ld = 0.30
          suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
        From table 5A.1, TBDY: esuv_nominal = 0.08,
        considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
        For calculation of esuv_nominal and   yv, shv,ftv,fyv, it is considered
        characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
          y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
          with fsv = fs = 311.2056
          with Esv = Es = 200000.00
      1 = Asl,ten/(b*d)*(fs1/fc) = 0.03861577
```

```
      2 = Asl,com/(b*d)*(fs2/fc) = 0.08132715
      v = Asl,mid/(b*d)*(fsv/fc) = 0.07196575
and confined core properties:
   b = 540.00
   d = 527.00
   d' = 13.00
   fcc (5A.2, TBDY) = 20.00
    cc (5A.5, TBDY) = 0.002
       c = confinement factor = 1.00
      1 = Asl,ten/(b*d)*(fs1/fc) = 0.0453489
      2 = Asl,com/(b*d)*(fs2/fc) = 0.09550753
      v = Asl,mid/(b*d)*(fsv/fc) = 0.08451386
Case/Assumption: Unconfinesd full section - Steel rupture
   ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.16341054
Mu = MRc (4.14) = 2.3955E+008
  u =   su (4.1) = 1.0987588E-005
-----------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
---------------------------------------------------------------------
---------------------------------------------------------------------
---------------------------------------------------------------------
Calculation of Mu2+
---------------------------------------------------------------------


---------------------------------------------------------------------
Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
   u = 1.3683047E-005
Mu = 4.1999E+008
---------------------------------------------------------------------
with full section properties:
   b = 250.00
   d = 557.00
   d' = 43.00
   v = 0.0031899
      N = 8883.864
   fc = 20.00
    co (5A.5, TBDY) = 0.002
   Final value of  cu:  cu* = shear_factor * Max( cu, cc) = 0.00768077
      The Shear_factor is considered equal to 1 (pure moment strength)
      From (5.4b), TBDY:  cu = 0.00768077
         we (5.4c) = 0.01092426
         ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
             The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
             of the rectangular sections confinement, which is expressed by (5.4d).
             The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
             "Theoretical Stress-Strain Model for Confined Concrete."
             J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
             Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
                     is calculated as the area of core enclosed by the center lines of the perimeter hoops.
             Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
                     is calculated by reducing all the dimensions of the area Aconf,max by a length
                     equal to half the clear spacing between hoops.
             AnoConf = 105733.333 is the unconfined core area which is equal to   bi2/6 as defined at (A.2).
         psh,min = Min(psh,x , psh,y) = 0.00482813
      Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
         -------------------------------------------------------------------
         psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
            Lstir (Length of stirrups along Y) = 1460.00
            Astir (stirrups area) = 78.53982
```

Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
    Lstir (Length of stirrups along X) = 1460.00
    Astir (stirrups area) = 78.53982
    Asec (section area) = 237500.00
----
    s = 100.00
    fywe = 555.55
    fce = 20.00
From ((5.A5), TBDY), TBDY: cc = 0.002
    c = confinement factor = 1.00
y1 = 0.00129669
sh1 = 0.0044814
ft1 = 373.4467
fy1 = 311.2056
su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
     su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
     with fs1 = fs = 311.2056
     with Es1 = Es = 200000.00
y2 = 0.00129669
sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.30
     su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
     with fs2 = fs = 311.2056
     with Es2 = Es = 200000.00
yv = 0.00129669
shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
     suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
     with fsv = fs = 311.2056
     with Esv = Es = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.19518516
    2 = Asl,com/(b*d)*(fs2/fc) = 0.09267785
    v = Asl,mid/(b*d)*(fsv/fc) = 0.17271781
and confined core properties:
b = 190.00
d = 527.00

d' = 13.00
fcc (5A.2, TBDY) = 20.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.27144246
2 = Asl,com/(b*d)*(fs2/fc) = 0.12888635
v = Asl,mid/(b*d)*(fsv/fc) = 0.24019729
Case/Assumption: Unconfinesd full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.8) = 0.32821245
Mu = MRc (4.15) = 4.1999E+008
u =   su (4.1) = 1.3683047E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
u = 1.0987588E-005
Mu = 2.3955E+008
----
with full section properties:
b = 600.00
d = 557.00
d' = 43.00
v = 0.00132912
N = 8883.864
fc = 20.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00768077
we (5.4c) = 0.01092426
ase = Max((((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the perimeter hoops.
Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max by a length
equal to half the clear spacing between hoops.
AnoConf = 105733.333 is the unconfined core area which is equal to   bi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

----
psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813

```
        Lstir (Length of stirrups along X) = 1460.00
        Astir (stirrups area) = 78.53982
        Asec (section area) = 237500.00

    -------------------------------------------------------------------
        s = 100.00
      fywe = 555.55
       fce = 20.00
    From ((5.A5), TBDY), TBDY:  cc = 0.002
         c = confinement factor = 1.00
  y1 = 0.00129669
 sh1 = 0.0044814
ft1 = 373.4467
fy1 = 311.2056
 su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
     su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and   y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
      with fs1 = fs = 311.2056
      with Es1 = Es = 200000.00
  y2 = 0.00129669
 sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
 su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.30
     su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and   y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
      with fs2 = fs = 311.2056
      with Es2 = Es = 200000.00
  yv = 0.00129669
 shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
 suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
     suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and   yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
      with fsv = fs = 311.2056
      with Esv = Es = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.03861577
    2 = Asl,com/(b*d)*(fs2/fc) = 0.08132715
    v = Asl,mid/(b*d)*(fsv/fc) = 0.07196575
and confined core properties:
  b = 540.00
  d = 527.00
  d' = 13.00
  fcc (5A.2, TBDY) = 20.00
   cc (5A.5, TBDY) = 0.002
```

```
    c  = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.0453489
    2 = Asl,com/(b*d)*(fs2/fc) = 0.09550753
    v = Asl,mid/(b*d)*(fsv/fc) = 0.08451386
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.16341054
Mu = MRc (4.14) = 2.3955E+008
  u =    su (4.1) = 1.0987588E-005
-------------------------------------------------------------

Calculation of ratio lb/ld
-------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
-----------------------------------------------------------------------
-----------------------------------------------------------------------
-----------------------------------------------------------------------
-----------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 424229.688
-----------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 424229.688
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 424229.688
  knl = 1 (zero step-static loading)
-------------------------------------------------------------
NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+   f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
-------------------------------------------------------------
    = 1 (normal-weight concrete)
  fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
     Mu = 47.13723
     Vu = 0.00016213
  d = 0.8*h = 480.00
  Nu = 8883.864
  Ag = 150000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 474724.809
  where:
  Vs1 = 139624.944 is calculated for section web, with:
    d = 200.00
    Av = 157079.633
    fy = 444.44
    s = 100.00
   Vs1 is multiplied by   Col1 = 1.00
     s/d = 0.50
   Vs2 = 335099.865 is calculated for section flange, with:
    d = 480.00
    Av = 157079.633
    fy = 444.44
    s = 100.00
   Vs2 is multiplied by   Col2 = 1.00
     s/d = 0.20833333
   Vf ((11-3)-(11.4), ACI 440) = 0.00
   From (11-11), ACI 440: Vs + Vf <= 356502.845
     bw = 250.00
-------------------------------------------------------------

-----------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 424229.688
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 424229.688
  knl = 1 (zero step-static loading)
-------------------------------------------------------------
NOTE: In expression (10-3) 'Vs' is replaced by 'Vs   f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
```

```
--------------------------------------------------------------
    = 1 (normal-weight concrete)
  fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
     Mu = 47.13721
     Vu = 0.00016213
  d = 0.8*h = 480.00
  Nu = 8883.864
  Ag = 150000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 474724.809
  where:
  Vs1 = 139624.944 is calculated for section web, with:
     d = 200.00
     Av = 157079.633
     fy = 444.44
     s = 100.00
  Vs1 is multiplied by   Col1 = 1.00
     s/d = 0.50
  Vs2 = 335099.865 is calculated for section flange, with:
     d = 480.00
     Av = 157079.633
     fy = 444.44
     s = 100.00
  Vs2 is multiplied by   Col2 = 1.00
     s/d = 0.20833333
  Vf ((11-3)-(11.4), ACI 440) = 0.00
  From (11-11), ACI 440: Vs + Vf <= 356502.845
     bw = 250.00
--------------------------------------------------------------
--------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At local axis: 2


--------------------------------------------------------------


Start Of Calculation of Chord Rotation Capacity for element: column LC1 of floor 1
At local axis: 3
Integration Section: (a)
Section Type: rclcs

Constant Properties
--------------------------------------------------------------
Knowledge Factor,   = 1.00
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lb/ld = 0.30
No FRP Wrapping
--------------------------------------------------------------

Stepwise Properties
```

```
------------------------------------------------------------
Bending Moment, M = -1.0691E+007
Shear Force, V2 = -3517.163
Shear Force, V3 = 121.1248
Axial Force, F = -9523.595
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
    -Compression: Aslc = 4121.77
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 1746.726
    -Compression: Asl,com = 829.3805
       -Middle: Asl,mid = 1545.664
Mean Diameter of Tension Reinforcement, DbL = 17.71429
------------------------------------------------------------
------------------------------------------------------------


Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity   u,R =   *  u = 0.03635684
  u =   y +   p = 0.03635684


------------------------------------------------------------
 - Calculation of   y -
------------------------------------------------------------
  y = (My*Ls/3)/EIeff = 0.00635684 ((4.29),Biskinis Phd))
  My = 2.6302E+008
  Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3039.574
  From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 4.1921E+013
     factor = 0.30
        Ag = 237500.00
        fc' = 20.00
        N = 9523.595
     Ec*Ig = 1.3974E+014
------------------------------------------------------------
------------------------------------------------------------

Calculation of Yielding Moment My
------------------------------------------------------------
Calculation of   y and My according to Annex 7   -
------------------------------------------------------------
  y = Min(  y_ten,  y_com)
  y_ten = 3.6310943E-006
  with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 248.9644
     d = 557.00
      y = 0.38451907
     A = 0.02987449
     B = 0.01925673
      with pt = 0.01254381
         pc = 0.00595605
         pv = 0.01109992
         N = 9523.595
         b = 250.00
          " = 0.07719928
  y_comp = 8.0244262E-006
 with fc = 20.00
     Ec = 21019.039
      y = 0.38319556
     A = 0.02940012
     B = 0.01898202
      with Es = 200000.00
------------------------------------------------------------
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30

------------------------------------------------------------
```

- Calculation of p -

From table 10-8: p = 0.03
with:
 - Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
   shear control ratio VyE/VColOE = 0.66001051
   d = 557.00
   s = 0.00
    t = Av/(bw*s) + 2*tf/bw*(ffe/fs) = Av*Lstir/(Ag*s) + 2*tf/bw*(ffe/fs) = 0.00
   Av = 78.53982, is the area of every stirrup
   Lstir = 1460.00, is the total Length of all stirrups parallel to loading (shear) direction
   The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
   where   f = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises f to steel strength
   All these variables have already been given in Shear control ratio calculation.
    NUD = 9523.595
    Ag = 237500.00
    f'cE = 20.00
    fytE = fylE = 0.00
pl = Area_Tot_Long_Rein/(b*d) = 0.02959978
  b = 250.00
  d = 557.00
    f'cE = 20.00

End Of Calculation of Chord Rotation Capacity for element: column LC1 of floor 1
At local axis: 3
Integration Section: (a)

Calculation No. 13

column C1, Floor 1

Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (2)

Start Of Calculation of Shear Capacity for element: column LC1 of floor 1
At local axis: 2
Integration Section: (b)
Section Type: rclcs

Constant Properties

Knowledge Factor,   = 1.00
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of y for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE41-17).
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.44
##
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min =lb/ld = 0.30
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -1.0691E+007
Shear Force, Va = -3517.163
EDGE -B-
Bending Moment, Mb = 135615.782
Shear Force, Vb = 3517.163
BOTH EDGES
Axial Force, F = -9523.595
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
   -Compression: Aslc = 4121.77
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 1746.726
   -Compression: Asl,com = 829.3805
      -Middle: Asl,mid = 1545.664
Mean Diameter of Tension Reinforcement, DbL,ten = 17.71429

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR =   *Vn = 440330.313
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 440330.313
   VCol = 440330.313
   knl = 1.00
      displacement_ductility_demand = 0.06282054

NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

    = 1 (normal-weight concrete)
  fc' = 16.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
     Mu = 135615.782
     Vu = 3517.163
  d = 0.8*h = 480.00
  Nu = 9523.595
  Ag = 150000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 427256.601
  where:
  Vs1 = 125663.706 is calculated for section web, with:
     d = 200.00
     Av = 157079.633
     fy = 400.00
     s = 100.00
  Vs1 is multiplied by   Col1 = 1.00
     s/d = 0.50
  Vs2 = 301592.895 is calculated for section flange, with:
     d = 480.00
     Av = 157079.633
     fy = 400.00
     s = 100.00
  Vs2 is multiplied by   Col2 = 1.00
     s/d = 0.20833333
  Vf ((11-3)-(11.4), ACI 440) = 0.00
  From (11-11), ACI 440: Vs + Vf <= 318865.838
     bw = 250.00

----
displacement_ductility_demand is calculated as   / y

 - Calculation of   / y for END B -
 for rotation axis 3 and integ. section (b)

From analysis, chord rotation   = 3.9414079E-005
 y = (My*Ls/3)/Eleff = 0.00062741 ((4.29),Biskinis Phd))
  My = 2.6302E+008
  Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 300.00
  From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 4.1921E+013
     factor = 0.30
        Ag = 237500.00
        fc' = 20.00
        N = 9523.595
     Ec*Ig = 1.3974E+014

Calculation of Yielding Moment My

Calculation of   y and My according to Annex 7   -
----
  y = Min(y_ten, y_com)
  y_ten = 3.6310943E-006
  with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 248.9644
     d = 557.00
      y = 0.38451907
     A = 0.02987449
     B = 0.01925673
     with pt = 0.01254381
         pc = 0.00595605
         pv = 0.01109992
         N = 9523.595
         b = 250.00

      " = 0.07719928
  y_comp = 8.0244262E-006
 with fc = 20.00
    Ec = 21019.039
     y = 0.38319556
    A = 0.02940012
    B = 0.01898202
    with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

End Of Calculation of Shear Capacity for element: column LC1 of floor 1
At local axis: 2
Integration Section: (b)

Calculation No. 14

column C1, Floor 1

Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (u)

Edge: End

Local Axis: (2)

Start Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rclcs

Constant Properties

Knowledge Factor, = 1.00
Mean strength values are used for both shear and moment calculations.

Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55
##
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = 0.00016213
EDGE -B-
Shear Force, Vb = -0.00016213
BOTH EDGES
Axial Force, F = -8883.864
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 4121.77
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1746.726
      -Compression: Asl,com = 829.3805
        -Middle: Asl,mid = 1545.664

Calculation of Shear Capacity ratio , Ve/Vr = 0.66001051
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 279996.052
with
Mpr1 = Max(Mu1+ , Mu1-) = 4.1999E+008
   Mu1+ = 4.1999E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
   Mu1- = 2.3955E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 4.1999E+008
   Mu2+ = 4.1999E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
   Mu2- = 2.3955E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:

u = 1.3683047E-005
Mu = 4.1999E+008
----
with full section properties:
  b = 250.00
  d = 557.00
  d' = 43.00
  v = 0.0031899
    N = 8883.864
  fc = 20.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00768077
      we (5.4c) = 0.01092426
      ase = Max((((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
          The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
          of the rectangular sections confinement, which is expressed by (5.4d).
          The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
          "Theoretical Stress-Strain Model for Confined Concrete."
          J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
          Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
                  is calculated as the area of core enclosed by the center lines of the perimeter hoops.
          Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
                  is calculated by reducing all the dimensions of the area Aconf,max by a length
                  equal to half the clear spacing between hoops.
          AnoConf = 105733.333 is the unconfined core area which is equal to   bi2/6 as defined at (A.2).
        psh,min = Min(psh,x , psh,y) = 0.00482813
    Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
        ----
        psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
          Lstir (Length of stirrups along Y) = 1460.00
          Astir (stirrups area) = 78.53982
          Asec (section area) = 237500.00
        ----
        psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
          Lstir (Length of stirrups along X) = 1460.00
          Astir (stirrups area) = 78.53982
          Asec (section area) = 237500.00
        ----
          s = 100.00
         fywe = 555.55
         fce = 20.00
      From ((5.A5), TBDY), TBDY: cc = 0.002
          c = confinement factor = 1.00
   y1 = 0.00129669
   sh1 = 0.0044814
  ft1 = 373.4467
  fy1 = 311.2056
   su1 = 0.00512
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/ld = 0.30
      su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esu1_nominal = 0.08,
     For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
     characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
        with fs1 = fs = 311.2056
        with Es1 = Es = 200000.00
   y2 = 0.00129669
   sh2 = 0.0044814
  ft2 = 373.4467
  fy2 = 311.2056
   su2 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
   su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and   y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
   y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
   with fs2 = fs = 311.2056
   with Es2 = Es = 200000.00
 yv = 0.00129669
 shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
 suv = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.30
     suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esuv_nominal = 0.08,
   considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
   For calculation of esuv_nominal and   yv, shv,ftv,fyv, it is considered
   characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
     with fsv = fs = 311.2056
     with Esv = Es = 200000.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.19518516
   2 = Asl,com/(b*d)*(fs2/fc) = 0.09267785
   v = Asl,mid/(b*d)*(fsv/fc) = 0.17271781
and confined core properties:
  b = 190.00
  d = 527.00
  d' = 13.00
  fcc (5A.2, TBDY) = 20.00
   cc (5A.5, TBDY) = 0.002
      c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.27144246
    2 = Asl,com/(b*d)*(fs2/fc) = 0.12888635
    v = Asl,mid/(b*d)*(fsv/fc) = 0.24019729
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
 su (4.8) = 0.32821245
Mu = MRc (4.15) = 4.1999E+008
  u =   su (4.1) = 1.3683047E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.0987588E-005
Mu = 2.3955E+008
----

with full section properties:
  b = 600.00
  d = 557.00
  d' = 43.00
  v = 0.00132912
    N = 8883.864
  fc = 20.00
  εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.00768077
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.00768077
      ωwe (5.4c) = 0.01092426
      αase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
          is calculated as the area of core enclosed by the center lines of the perimeter hoops.
        Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
          is calculated by reducing all the dimensions of the area Aconf,max by a length
          equal to half the clear spacing between hoops.
        AnoConf = 105733.333 is the unconfined core area which is equal to bi2/6 as defined at (A.2).
      ρsh,min = Min(ρsh,x , ρsh,y) = 0.00482813
    Expression ((5.4d), TBDY) for ρsh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

      ρsh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
        Lstir (Length of stirrups along Y) = 1460.00
        Astir (stirrups area) = 78.53982
        Asec (section area) = 237500.00

      ρsh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
        Lstir (Length of stirrups along X) = 1460.00
        Astir (stirrups area) = 78.53982
        Asec (section area) = 237500.00
    ----
      s = 100.00
     fywe = 555.55
     fce = 20.00
   From ((5.A5), TBDY), TBDY: εcc = 0.002
      εc = confinement factor = 1.00
  εy1 = 0.00129669
  εsh1 = 0.0044814
 ft1 = 373.4467
 fy1 = 311.2056
  εsu1 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.30
   εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esu1_nominal = 0.08,
   For calculation of esu1_nominal and εy1, εsh1,ft1,fy1, it is considered
   characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
   εy1, εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
    with fs1 = fs = 311.2056
    with Es1 = Es = 200000.00
  εy2 = 0.00129669
  εsh2 = 0.0044814
 ft2 = 373.4467
 fy2 = 311.2056
  εsu2 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.30
          su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
        From table 5A.1, TBDY: esu2_nominal = 0.08,
        For calculation of esu2_nominal and   y2, sh2,ft2,fy2, it is considered
        characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
          y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
          with fs2 = fs = 311.2056
          with Es2 = Es = 200000.00
     yv = 0.00129669
     shv = 0.0044814
   ftv = 373.4467
   fyv = 311.2056
     suv = 0.00512
       using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
       and also multiplied by the shear_factor according to 15.7.1.4, with
       Shear_factor = 1.00
       lo/lou,min = lb/ld = 0.30
         suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
       From table 5A.1, TBDY: esuv_nominal = 0.08,
       considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
       For calculation of esuv_nominal and   yv, shv,ftv,fyv, it is considered
       characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
         y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
         with fsv = fs = 311.2056
         with Esv = Es = 200000.00
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.03861577
     2 = Asl,com/(b*d)*(fs2/fc) = 0.08132715
     v = Asl,mid/(b*d)*(fsv/fc) = 0.07196575
and confined core properties:
   b = 540.00
   d = 527.00
   d' = 13.00
   fcc (5A.2, TBDY) = 20.00
     cc (5A.5, TBDY) = 0.002
        c = confinement factor = 1.00
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.0453489
     2 = Asl,com/(b*d)*(fs2/fc) = 0.09550753
     v = Asl,mid/(b*d)*(fsv/fc) = 0.08451386
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.16341054
Mu = MRc (4.14) = 2.3955E+008
  u =   su (4.1) = 1.0987588E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.3683047E-005
Mu = 4.1999E+008
----
with full section properties:
   b = 250.00
   d = 557.00
   d' = 43.00
   v = 0.0031899

N = 8883.864
fc = 20.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
   The Shear_factor is considered equal to 1 (pure moment strength)
   From (5.4b), TBDY: cu = 0.00768077
      we (5.4c) = 0.01092426
      ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
         The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
         of the rectangular sections confinement, which is expressed by (5.4d).
         The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
         "Theoretical Stress-Strain Model for Confined Concrete."
         J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
         Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
               is calculated as the area of core enclosed by the center lines of the perimeter hoops.
         Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
               is calculated by reducing all the dimensions of the area Aconf,max by a length
               equal to half the clear spacing between hoops.
         AnoConf = 105733.333 is the unconfined core area which is equal to bi2/6 as defined at (A.2).
      psh,min = Min(psh,x , psh,y) = 0.00482813
   Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
      ----
      psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
         Lstir (Length of stirrups along Y) = 1460.00
         Astir (stirrups area) = 78.53982
         Asec (section area) = 237500.00
      ----
      psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
         Lstir (Length of stirrups along X) = 1460.00
         Astir (stirrups area) = 78.53982
         Asec (section area) = 237500.00
      ----
         s = 100.00
      fywe = 555.55
      fce = 20.00
   From ((5.A5), TBDY), TBDY: cc = 0.002
      c = confinement factor = 1.00
 y1 = 0.00129669
 sh1 = 0.0044814
ft1 = 373.4467
fy1 = 311.2056
 su1 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.30
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esu1_nominal = 0.08,
   For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
   characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
    with fs1 = fs = 311.2056
    with Es1 = Es = 200000.00
 y2 = 0.00129669
 sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
 su2 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/lb,min = 0.30
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esu2_nominal = 0.08,
   For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
   characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
  with fs2 = fs = 311.2056
  with Es2 = Es = 200000.00
yv = 0.00129669
shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
suv = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
  suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esuv_nominal = 0.08,
  considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
  For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
  characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
  with fsv = fs = 311.2056
  with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.19518516
2 = Asl,com/(b*d)*(fs2/fc) = 0.09267785
v = Asl,mid/(b*d)*(fsv/fc) = 0.17271781
and confined core properties:
b = 190.00
d = 527.00
d' = 13.00
fcc (5A.2, TBDY) = 20.00
cc (5A.5, TBDY) = 0.002
  c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.27144246
2 = Asl,com/(b*d)*(fs2/fc) = 0.12888635
v = Asl,mid/(b*d)*(fsv/fc) = 0.24019729
Case/Assumption: Unconfinesd full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.8) = 0.32821245
Mu = MRc (4.15) = 4.1999E+008
u =   su (4.1) = 1.3683047E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
u = 1.0987588E-005
Mu = 2.3955E+008
----
with full section properties:
b = 600.00
d = 557.00
d' = 43.00
v = 0.00132912
  N = 8883.864
fc = 20.00
co (5A.5, TBDY) = 0.002

Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
   The Shear_factor is considered equal to 1 (pure moment strength)
   From (5.4b), TBDY: cu = 0.00768077
     we (5.4c) = 0.01092426
     ase = Max((((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
              is calculated as the area of core enclosed by the center lines of the perimeter hoops.
        Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
              is calculated by reducing all the dimensions of the area Aconf,max by a length
              equal to half the clear spacing between hoops.
        AnoConf = 105733.333 is the unconfined core area which is equal to bi2/6 as defined at (A.2).
     psh,min = Min(psh,x , psh,y) = 0.00482813
   Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
        ----
        psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
           Lstir (Length of stirrups along Y) = 1460.00
           Astir (stirrups area) = 78.53982
           Asec (section area) = 237500.00
        ----
        psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
           Lstir (Length of stirrups along X) = 1460.00
           Astir (stirrups area) = 78.53982
           Asec (section area) = 237500.00
        ----
           s = 100.00
          fywe = 555.55
          fce = 20.00
     From ((5.A5), TBDY), TBDY: cc = 0.002
          c = confinement factor = 1.00
   y1 = 0.00129669
   sh1 = 0.0044814
  ft1 = 373.4467
  fy1 = 311.2056
   su1 = 0.00512
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/ld = 0.30
      su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esu1_nominal = 0.08,
     For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
     characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
      with fs1 = fs = 311.2056
      with Es1 = Es = 200000.00
   y2 = 0.00129669
   sh2 = 0.0044814
  ft2 = 373.4467
  fy2 = 311.2056
   su2 = 0.00512
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/lb,min = 0.30
      su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esu2_nominal = 0.08,
     For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
     characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
      with fs2 = fs = 311.2056
      with Es2 = Es = 200000.00

yv = 0.00129669
shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
suv = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
   suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esuv_nominal = 0.08,
  considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
  For calculation of esuv_nominal and   yv, shv,ftv,fyv, it is considered
  characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
   y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
   with fsv = fs = 311.2056
   with Esv = Es = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.03861577
  2 = Asl,com/(b*d)*(fs2/fc) = 0.08132715
  v = Asl,mid/(b*d)*(fsv/fc) = 0.07196575
and confined core properties:
  b = 540.00
  d = 527.00
  d' = 13.00
  fcc (5A.2, TBDY) = 20.00
  cc (5A.5, TBDY) = 0.002
   c = confinement factor = 1.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.0453489
  2 = Asl,com/(b*d)*(fs2/fc) = 0.09550753
  v = Asl,mid/(b*d)*(fsv/fc) = 0.08451386
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.16341054
Mu = MRc (4.14) = 2.3955E+008
 u =   su (4.1) = 1.0987588E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 424229.688

Calculation of Shear Strength at edge 1, Vr1 = 424229.688
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 424229.688
  knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+   f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

    = 1 (normal-weight concrete)
  fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
   Mu = 47.14131
   Vu = 0.00016213
  d = 0.8*h = 480.00
  Nu = 8883.864
  Ag = 150000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 474724.809
  where:

Vs1 = 335099.865 is calculated for section web, with:
   d = 480.00
   Av = 157079.633
   fy = 444.44
   s = 100.00
  Vs1 is multiplied by   Col1 = 1.00
   s/d = 0.20833333
  Vs2 = 139624.944 is calculated for section flange, with:
   d = 200.00
   Av = 157079.633
   fy = 444.44
   s = 100.00
  Vs2 is multiplied by   Col2 = 1.00
   s/d = 0.50
  Vf ((11-3)-(11.4), ACI 440) = 0.00
  From (11-11), ACI 440: Vs + Vf <= 356502.845
   bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 424229.688
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 424229.688
  knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

   = 1 (normal-weight concrete)
  fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
   Mu = 47.14134
   Vu = 0.00016213
  d = 0.8*h = 480.00
  Nu = 8883.864
  Ag = 150000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 474724.809
  where:
  Vs1 = 335099.865 is calculated for section web, with:
   d = 480.00
   Av = 157079.633
   fy = 444.44
   s = 100.00
  Vs1 is multiplied by   Col1 = 1.00
   s/d = 0.20833333
  Vs2 = 139624.944 is calculated for section flange, with:
   d = 200.00
   Av = 157079.633
   fy = 444.44
   s = 100.00
  Vs2 is multiplied by   Col2 = 1.00
   s/d = 0.50
  Vf ((11-3)-(11.4), ACI 440) = 0.00
  From (11-11), ACI 440: Vs + Vf <= 356502.845
   bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rclcs

Constant Properties

Knowledge Factor,   = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55
###
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = 0.00016213
EDGE -B-
Shear Force, Vb = -0.00016213
BOTH EDGES
Axial Force, F = -8883.864
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
    -Compression: Aslc = 4121.77
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 1746.726
    -Compression: Asl,com = 829.3805
      -Middle: Asl,mid = 1545.664

Calculation of Shear Capacity ratio , Ve/Vr = 0.66001051
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 279996.052
with
Mpr1 = Max(Mu1+ , Mu1-) = 4.1999E+008
   Mu1+ = 4.1999E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
   Mu1- = 2.3955E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 4.1999E+008
   Mu2+ = 4.1999E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
   Mu2- = 2.3955E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 1.3683047E-005
Mu = 4.1999E+008
----
with full section properties:
  b = 250.00
  d = 557.00
  d' = 43.00
  ν = 0.0031899
    N = 8883.864
  fc = 20.00
   εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.00768077
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.00768077
      ωwe (5.4c) = 0.01092426
      αase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
          The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
          of the rectangular sections confinement, which is expressed by (5.4d).
          The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
          "Theoretical Stress-Strain Model for Confined Concrete."
          J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
          Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
                  is calculated as the area of core enclosed by the center lines of the perimeter hoops.
          Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
                  is calculated by reducing all the dimensions of the area Aconf,max by a length
                  equal to half the clear spacing between hoops.
          AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
      ρsh,min = Min(ρsh,x , ρsh,y) = 0.00482813
    Expression ((5.4d), TBDY) for ρsh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

      ρsh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
          Lstir (Length of stirrups along Y) = 1460.00
          Astir (stirrups area) = 78.53982
          Asec (section area) = 237500.00

      ρsh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
          Lstir (Length of stirrups along X) = 1460.00
          Astir (stirrups area) = 78.53982
          Asec (section area) = 237500.00
      ----
        s = 100.00
        fywe = 555.55
        fce = 20.00
    From ((5.A5), TBDY), TBDY: εcc = 0.002
        αc = confinement factor = 1.00
  εy1 = 0.00129669
  εsh1 = 0.0044814
  ft1 = 373.4467
  fy1 = 311.2056
   εsu1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
     εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and εy1, εsh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
     εy1, εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
      with fs1 = fs = 311.2056
      with Es1 = Es = 200000.00
   εy2 = 0.00129669

sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
 su2 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/lb,min = 0.30
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esu2_nominal = 0.08,
   For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
   characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
    with fs2 = fs = 311.2056
    with Es2 = Es = 200000.00
 yv = 0.00129669
 shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
 suv = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.30
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esuv_nominal = 0.08,
   considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
   For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
   characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
    with fsv = fs = 311.2056
    with Esv = Es = 200000.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.19518516
   2 = Asl,com/(b*d)*(fs2/fc) = 0.09267785
   v = Asl,mid/(b*d)*(fsv/fc) = 0.17271781
and confined core properties:
 b = 190.00
 d = 527.00
 d' = 13.00
 fcc (5A.2, TBDY) = 20.00
  cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.27144246
   2 = Asl,com/(b*d)*(fs2/fc) = 0.12888635
   v = Asl,mid/(b*d)*(fsv/fc) = 0.24019729
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
 su (4.8) = 0.32821245
Mu = MRc (4.15) = 4.1999E+008
  u =   su (4.1) = 1.3683047E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 1.0987588E-005
Mu = 2.3955E+008
----
with full section properties:
  b = 600.00
  d = 557.00
  d' = 43.00
  ν = 0.00132912
    N = 8883.864
  fc = 20.00
   εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.00768077
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: εcu = 0.00768077
       ωwe (5.4c) = 0.01092426
       αase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
          The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
          of the rectangular sections confinement, which is expressed by (5.4d).
          The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
          "Theoretical Stress-Strain Model for Confined Concrete."
          J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
          Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
                 is calculated as the area of core enclosed by the center lines of the perimeter hoops.
          Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
                 is calculated by reducing all the dimensions of the area Aconf,max by a length
                 equal to half the clear spacing between hoops.
          AnoConf = 105733.333 is the unconfined core area which is equal to Σbi2/6 as defined at (A.2).
       ρsh,min = Min(ρsh,x , ρsh,y) = 0.00482813
     Expression ((5.4d), TBDY) for ρsh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

       ρsh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
          Lstir (Length of stirrups along Y) = 1460.00
          Astir (stirrups area) = 78.53982
          Asec (section area) = 237500.00

       ρsh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
          Lstir (Length of stirrups along X) = 1460.00
          Astir (stirrups area) = 78.53982
          Asec (section area) = 237500.00
       ----
          s = 100.00
          fywe = 555.55
          fce = 20.00
     From ((5.A5), TBDY), TBDY: εcc = 0.002
          αc = confinement factor = 1.00
   εy1 = 0.00129669
   εsh1 = 0.0044814
  ft1 = 373.4467
  fy1 = 311.2056
   εsu1 = 0.00512
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/ld = 0.30
      εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esu1_nominal = 0.08,
     For calculation of esu1_nominal and εy1, εsh1,ft1,fy1, it is considered
     characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
      εy1, εsh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
       with fs1 = fs = 311.2056
       with Es1 = Es = 200000.00
   εy2 = 0.00129669
   εsh2 = 0.0044814
  ft2 = 373.4467
  fy2 = 311.2056

su2 = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/lb,min = 0.30
   su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esu2_nominal = 0.08,
  For calculation of esu2_nominal and   y2, sh2,ft2,fy2, it is considered
  characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
   y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
   with fs2 = fs = 311.2056
   with Es2 = Es = 200000.00
 yv = 0.00129669
 shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
 suv = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
   suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esuv_nominal = 0.08,
  considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
  For calculation of esuv_nominal and   yv, shv,ftv,fyv, it is considered
  characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
   y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
   with fsv = fs = 311.2056
   with Esv = Es = 200000.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.03861577
 2 = Asl,com/(b*d)*(fs2/fc) = 0.08132715
 v = Asl,mid/(b*d)*(fsv/fc) = 0.07196575
and confined core properties:
 b = 540.00
 d = 527.00
 d' = 13.00
 fcc (5A.2, TBDY) = 20.00
  cc (5A.5, TBDY) = 0.002
   c = confinement factor = 1.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.0453489
  2 = Asl,com/(b*d)*(fs2/fc) = 0.09550753
  v = Asl,mid/(b*d)*(fsv/fc) = 0.08451386
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.16341054
Mu = MRc (4.14) = 2.3955E+008
 u =   su (4.1) = 1.0987588E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
 u = 1.3683047E-005
Mu = 4.1999E+008
----
with full section properties:

b = 250.00
d = 557.00
d' = 43.00
v = 0.0031899
  N = 8883.864
fc = 20.00
 co (5A.5, TBDY) = 0.002
Final value of cu: $cu^* = shear\_factor * Max(cu, cc) = 0.00768077$
  The Shear_factor is considered equal to 1 (pure moment strength)
  From (5.4b), TBDY: cu = 0.00768077
    we (5.4c) = 0.01092426
    ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
      The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
      of the rectangular sections confinement, which is expressed by (5.4d).
      The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
      "Theoretical Stress-Strain Model for Confined Concrete."
      J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
      Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
          is calculated as the area of core enclosed by the center lines of the perimeter hoops.
      Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
          is calculated by reducing all the dimensions of the area Aconf,max by a length
          equal to half the clear spacing between hoops.
      AnoConf = 105733.333 is the unconfined core area which is equal to bi2/6 as defined at (A.2).
    psh,min = Min(psh,x , psh,y) = 0.00482813
  Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

    ----
    psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
      Lstir (Length of stirrups along Y) = 1460.00
      Astir (stirrups area) = 78.53982
      Asec (section area) = 237500.00
    ----
    psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
      Lstir (Length of stirrups along X) = 1460.00
      Astir (stirrups area) = 78.53982
      Asec (section area) = 237500.00
    ----
      s = 100.00
      fywe = 555.55
      fce = 20.00
    From ((5.A5), TBDY), TBDY: cc = 0.002
      c = confinement factor = 1.00
 y1 = 0.00129669
 sh1 = 0.0044814
ft1 = 373.4467
fy1 = 311.2056
 su1 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.30
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esu1_nominal = 0.08,
   For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
   characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
    with fs1 = fs = 311.2056
    with Es1 = Es = 200000.00
 y2 = 0.00129669
 sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
 su2 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/lb,min = 0.30

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
 From table 5A.1, TBDY: esu2_nominal = 0.08,
 For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
 characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
  with fs2 = fs = 311.2056
  with Es2 = Es = 200000.00
 yv = 0.00129669
 shv = 0.0044814
 ftv = 373.4467
 fyv = 311.2056
 suv = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
  suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
 From table 5A.1, TBDY: esuv_nominal = 0.08,
 considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
 For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
 characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
  with fsv = fs = 311.2056
  with Esv = Es = 200000.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.19518516
 2 = Asl,com/(b*d)*(fs2/fc) = 0.09267785
 v = Asl,mid/(b*d)*(fsv/fc) = 0.17271781
and confined core properties:
 b = 190.00
 d = 527.00
 d' = 13.00
 fcc (5A.2, TBDY) = 20.00
  cc (5A.5, TBDY) = 0.002
   c = confinement factor = 1.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.27144246
  2 = Asl,com/(b*d)*(fs2/fc) = 0.12888635
  v = Asl,mid/(b*d)*(fsv/fc) = 0.24019729
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
 su (4.8) = 0.32821245
Mu = MRc (4.15) = 4.1999E+008
 u =   su (4.1) = 1.3683047E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
 u = 1.0987588E-005
Mu = 2.3955E+008
----
with full section properties:
 b = 600.00
 d = 557.00
 d' = 43.00

v = 0.00132912
  N = 8883.864
fc = 20.00
 co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
   The Shear_factor is considered equal to 1 (pure moment strength)
   From (5.4b), TBDY: cu = 0.00768077
    we (5.4c) = 0.01092426
    ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
      The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
      of the rectangular sections confinement, which is expressed by (5.4d).
      The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
      "Theoretical Stress-Strain Model for Confined Concrete."
      J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
      Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
         is calculated as the area of core enclosed by the center lines of the perimeter hoops.
      Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
         is calculated by reducing all the dimensions of the area Aconf,max by a length
         equal to half the clear spacing between hoops.
      AnoConf = 105733.333 is the unconfined core area which is equal to bi2/6 as defined at (A.2).
    psh,min = Min(psh,x , psh,y) = 0.00482813
  Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

    ----
    psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
      Lstir (Length of stirrups along Y) = 1460.00
      Astir (stirrups area) = 78.53982
      Asec (section area) = 237500.00
    ----
    psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
      Lstir (Length of stirrups along X) = 1460.00
      Astir (stirrups area) = 78.53982
      Asec (section area) = 237500.00
    ----
     s = 100.00
     fywe = 555.55
     fce = 20.00
   From ((5.A5), TBDY), TBDY: cc = 0.002
     c = confinement factor = 1.00
 y1 = 0.00129669
 sh1 = 0.0044814
ft1 = 373.4467
fy1 = 311.2056
 su1 = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
  su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esu1_nominal = 0.08,
  For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
  characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
  with fs1 = fs = 311.2056
  with Es1 = Es = 200000.00
 y2 = 0.00129669
 sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
 su2 = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/lb,min = 0.30
  su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esu2_nominal = 0.08,
  For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered

characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
      with fs2 = fs = 311.2056
      with Es2 = Es = 200000.00
  yv = 0.00129669
  shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
  suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
      suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
      with fsv = fs = 311.2056
      with Esv = Es = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.03861577
  2 = Asl,com/(b*d)*(fs2/fc) = 0.08132715
  v = Asl,mid/(b*d)*(fsv/fc) = 0.07196575
and confined core properties:
  b = 540.00
  d = 527.00
  d' = 13.00
  fcc (5A.2, TBDY) = 20.00
    cc (5A.5, TBDY) = 0.002
      c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.0453489
    2 = Asl,com/(b*d)*(fs2/fc) = 0.09550753
    v = Asl,mid/(b*d)*(fsv/fc) = 0.08451386
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.16341054
Mu = MRc (4.14) = 2.3955E+008
  u =   su (4.1) = 1.0987588E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 424229.688

Calculation of Shear Strength at edge 1, Vr1 = 424229.688
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 424229.688
  knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

    = 1 (normal-weight concrete)
  fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
    Mu = 47.13723
    Vu = 0.00016213
  d = 0.8*h = 480.00

```
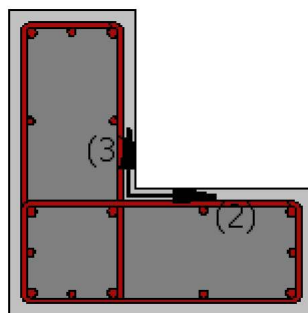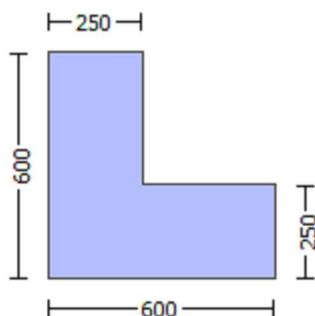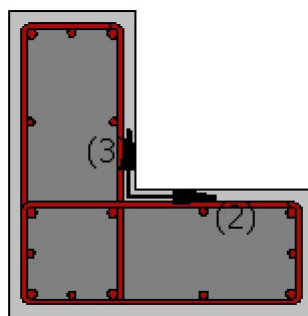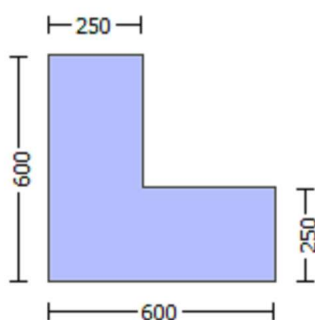Nu = 8883.864
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 474724.809
where:
Vs1 = 139624.944 is calculated for section web, with:
   d = 200.00
   Av = 157079.633
   fy = 444.44
   s = 100.00
Vs1 is multiplied by   Col1 = 1.00
   s/d = 0.50
Vs2 = 335099.865 is calculated for section flange, with:
   d = 480.00
   Av = 157079.633
   fy = 444.44
   s = 100.00
Vs2 is multiplied by   Col2 = 1.00
   s/d = 0.20833333
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 356502.845
   bw = 250.00
-------------------------------------------------------------
---------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 424229.688
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
   VCol0 = 424229.688
   knl = 1 (zero step-static loading)
-------------------------------------------------------------
NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+ $_f$*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
-------------------------------------------------------------
     = 1 (normal-weight concrete)
fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 4.00
   Mu = 47.13721
   Vu = 0.00016213
d = 0.8*h = 480.00
Nu = 8883.864
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 474724.809
where:
Vs1 = 139624.944 is calculated for section web, with:
   d = 200.00
   Av = 157079.633
   fy = 444.44
   s = 100.00
Vs1 is multiplied by   Col1 = 1.00
   s/d = 0.50
Vs2 = 335099.865 is calculated for section flange, with:
   d = 480.00
   Av = 157079.633
   fy = 444.44
   s = 100.00
Vs2 is multiplied by   Col2 = 1.00
   s/d = 0.20833333
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 356502.845
   bw = 250.00
-------------------------------------------------------------
-------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At local axis: 2

-------------------------------------------------------------


Start Of Calculation of Chord Rotation Capacity for element: column LC1 of floor 1
```

At local axis: 2
Integration Section: (b)
Section Type: rclcs

Constant Properties

Knowledge Factor, = 1.00
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lb/ld = 0.30
No FRP Wrapping

Stepwise Properties

Bending Moment, M = -99752.057
Shear Force, V2 = 3517.163
Shear Force, V3 = -121.1248
Axial Force, F = -9523.595
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 4121.77
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1746.726
     -Compression: Asl,com = 829.3805
        -Middle: Asl,mid = 1545.664
Mean Diameter of Tension Reinforcement, DbL = 17.71429

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity u,R = * u = 0.03172233
 u = y + p = 0.03172233

 - Calculation of y -
----
 y = (My*Ls/3)/Eleff = 0.00172233 ((4.29),Biskinis Phd))
 My = 2.6302E+008
 Ls = M/V (with Ls > 0.1*L and Ls < 2*L) = 823.5475
 From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 4.1921E+013
    factor = 0.30
      Ag = 237500.00
      fc' = 20.00
      N = 9523.595
    Ec*Ig = 1.3974E+014

Calculation of Yielding Moment My

Calculation of   y and My according to Annex 7   -
----
  y = Min(y_ten, y_com)
  y_ten = 3.6310943E-006
  with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 248.9644
     d = 557.00
      y = 0.38451907
     A = 0.02987449
     B = 0.01925673
      with pt = 0.01254381
          pc = 0.00595605
          pv = 0.01109992
          N = 9523.595
          b = 250.00
          " = 0.07719928
  y_comp = 8.0244262E-006
  with fc = 20.00
     Ec = 21019.039
      y = 0.38319556
     A = 0.02940012
     B = 0.01898202
      with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

 - Calculation of   p -

From table 10-8:   p = 0.03
with:
 - Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
   shear control ratio VyE/VColOE = 0.66001051
   d = 557.00
   s = 0.00
    t = Av/(bw*s) + 2*tf/bw*(ffe/fs) = Av*Lstir/(Ag*s) + 2*tf/bw*(ffe/fs) = 0.00
   Av = 78.53982, is the area of every stirrup
   Lstir = 1460.00, is the total Length of all stirrups parallel to loading (shear) direction
   The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
   where   f = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises   f to steel strength
   All these variables have already been given in Shear control ratio calculation.
    NUD = 9523.595
    Ag = 237500.00
    f'cE = 20.00
    fytE = fylE = 0.00
pl = Area_Tot_Long_Rein/(b*d) = 0.02959978
   b = 250.00
   d = 557.00
    f'cE = 20.00

End Of Calculation of Chord Rotation Capacity for element: column LC1 of floor 1
At local axis: 2
Integration Section: (b)

Calculation No. 15

column C1, Floor 1

Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (3)

Start Of Calculation of Shear Capacity for element: column LC1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rclcs

Constant Properties

Knowledge Factor, = 1.00
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of y for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE41-17).
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.44
##
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min =lb/ld = 0.30
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -262290.50
Shear Force, Va = 121.1248
EDGE -B-
Bending Moment, Mb = -99752.057
Shear Force, Vb = -121.1248
BOTH EDGES
Axial Force, F = -9523.595
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 4121.77
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1746.726
     -Compression: Asl,com = 829.3805
         -Middle: Asl,mid = 1545.664
Mean Diameter of Tension Reinforcement, DbL,ten = 17.71429

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR =   *Vn = 440330.313
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 440330.313
  VCol = 440330.313
  knl = 1.00
     displacement_ductility_demand = 1.3057390E-005

NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+   f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

    = 1 (normal-weight concrete)
 fc' = 16.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
 M/Vd = 2.00
     Mu = 99752.057
     Vu = 121.1248
  d = 0.8*h = 480.00
  Nu = 9523.595
  Ag = 150000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 427256.601
  where:
  Vs1 = 301592.895 is calculated for section web, with:
    d = 480.00
    Av = 157079.633
    fy = 400.00
    s = 100.00
  Vs1 is multiplied by   Col1 = 1.00
    s/d = 0.20833333
  Vs2 = 125663.706 is calculated for section flange, with:
    d = 200.00
    Av = 157079.633
    fy = 400.00
    s = 100.00
  Vs2 is multiplied by   Col2 = 1.00
    s/d = 0.50
  Vf ((11-3)-(11.4), ACI 440) = 0.00
  From (11-11), ACI 440: Vs + Vf <= 318865.838
    bw = 250.00

----
displacement_ductility_demand is calculated as   / y

- Calculation of   / y for END B -
 for rotation axis 2 and integ. section (b)

From analysis, chord rotation   = 2.2489172E-008
 y = (My*Ls/3)/EIeff = 0.00172233 ((4.29),Biskinis Phd))
  My = 2.6302E+008
  Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 823.5475
  From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 4.1921E+013
    factor = 0.30
      Ag = 237500.00
      fc' = 20.00
      N = 9523.595
    Ec*Ig = 1.3974E+014

Calculation of Yielding Moment My

Calculation of   y and My according to Annex 7   -
----
  y = Min(y_ten, y_com)
  y_ten = 3.6310943E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^ 2/3) = 248.9644
    d = 557.00
     y = 0.38451907
    A = 0.02987449
    B = 0.01925673
    with pt = 0.01254381
       pc = 0.00595605
       pv = 0.01109992
       N = 9523.595
       b = 250.00
       " = 0.07719928
  y_comp = 8.0244262E-006
 with fc = 20.00
    Ec = 21019.039
     y = 0.38319556
    A = 0.02940012
    B = 0.01898202
    with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

End Of Calculation of Shear Capacity for element: column LC1 of floor 1
At local axis: 3
Integration Section: (b)

Calculation No. 16

column C1, Floor 1

Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (u)

Edge: End

Local Axis: (3)

Start Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rclcs

Constant Properties

Knowledge Factor,   = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55
##
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-

Shear Force, Va = 0.00016213
EDGE -B-
Shear Force, Vb = -0.00016213
BOTH EDGES
Axial Force, F = -8883.864
Longitudinal Reinforcement Area Distribution (in 2 divisions)
     -Tension: Aslt = 0.00
   -Compression: Aslc = 4121.77
Longitudinal Reinforcement Area Distribution (in 3 divisions)
     -Tension: Asl,ten = 1746.726
   -Compression: Asl,com = 829.3805
      -Middle: Asl,mid = 1545.664

Calculation of Shear Capacity ratio , Ve/Vr = 0.66001051
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 279996.052
with
Mpr1 = Max(Mu1+ , Mu1-) = 4.1999E+008
  Mu1+ = 4.1999E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
  Mu1- = 2.3955E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 4.1999E+008
  Mu2+ = 4.1999E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
  Mu2- = 2.3955E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 u = 1.3683047E-005
Mu = 4.1999E+008
----
with full section properties:
  b = 250.00
  d = 557.00
  d' = 43.00
  v = 0.0031899
    N = 8883.864
  fc = 20.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00768077
      we (5.4c) = 0.01092426
       ase = Max((((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
          The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
          of the rectangular sections confinement, which is expressed by (5.4d).
          The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
          "Theoretical Stress-Strain Model for Confined Concrete."
          J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
          Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
                 is calculated as the area of core enclosed by the center lines of the perimeter hoops.
          Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
                  is calculated by reducing all the dimensions of the area Aconf,max by a length
                  equal to half the clear spacing between hoops.
          AnoConf = 105733.333 is the unconfined core area which is equal to bi2/6 as defined at (A.2).
       psh,min = Min(psh,x , psh,y) = 0.00482813
    Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

```
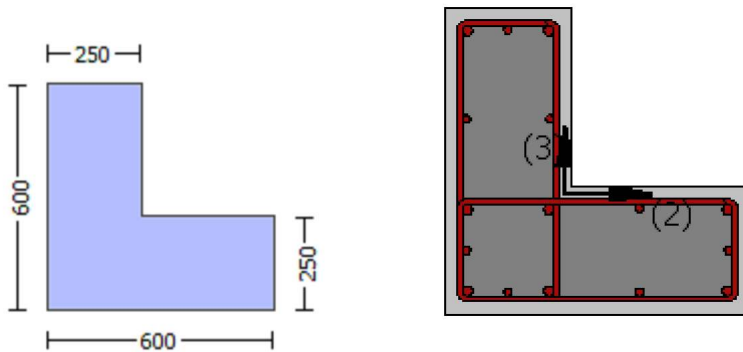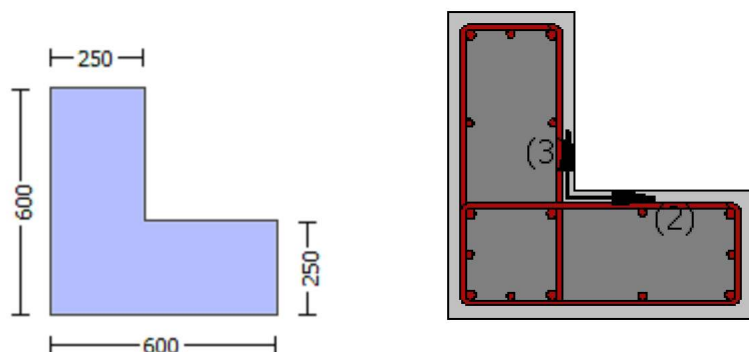  -----------------------------------------------------------------
      psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
          Lstir (Length of stirrups along Y) = 1460.00
          Astir (stirrups area) = 78.53982
          Asec (section area) = 237500.00
  -----------------------------------------------------------------
      psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
          Lstir (Length of stirrups along X) = 1460.00
          Astir (stirrups area) = 78.53982
          Asec (section area) = 237500.00
  -----------------------------------------------------------------
          s = 100.00
        fywe = 555.55
        fce = 20.00
    From ((5.A5), TBDY), TBDY:  cc = 0.002
          c = confinement factor = 1.00
  y1 = 0.00129669
  sh1 = 0.0044814
 ft1 = 373.4467
 fy1 = 311.2056
  su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
      su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
      with fs1 = fs = 311.2056
      with Es1 = Es = 200000.00
  y2 = 0.00129669
  sh2 = 0.0044814
 ft2 = 373.4467
 fy2 = 311.2056
  su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.30
      su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
      with fs2 = fs = 311.2056
      with Es2 = Es = 200000.00
  yv = 0.00129669
  shv = 0.0044814
 ftv = 373.4467
 fyv = 311.2056
  suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
      suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and  yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
      with fsv = fs = 311.2056
      with Esv = Es = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.19518516
    2 = Asl,com/(b*d)*(fs2/fc) = 0.09267785
```

v = Asl,mid/(b*d)*(fsv/fc) = 0.17271781
and confined core properties:
  b = 190.00
  d = 527.00
  d' = 13.00
  fcc (5A.2, TBDY) = 20.00
   cc (5A.5, TBDY) = 0.002
       c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.27144246
    2 = Asl,com/(b*d)*(fs2/fc) = 0.12888635
    v = Asl,mid/(b*d)*(fsv/fc) = 0.24019729
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
 su (4.8) = 0.32821245
Mu = MRc (4.15) = 4.1999E+008
  u =   su (4.1) = 1.3683047E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.0987588E-005
Mu = 2.3955E+008
----
with full section properties:
  b = 600.00
  d = 557.00
  d' = 43.00
  v = 0.00132912
    N = 8883.864
  fc = 20.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00768077
      we (5.4c) = 0.01092426
     ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
              is calculated as the area of core enclosed by the center lines of the perimeter hoops.
        Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
              is calculated by reducing all the dimensions of the area Aconf,max by a length
              equal to half the clear spacing between hoops.
        AnoConf = 105733.333 is the unconfined core area which is equal to   bi2/6 as defined at (A.2).
      psh,min = Min(psh,x , psh,y) = 0.00482813
    Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
      ----
        psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
          Lstir (Length of stirrups along Y) = 1460.00

```
              Astir (stirrups area) = 78.53982
              Asec (section area) = 237500.00
        -------------------------------------------------------------------
           psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
              Lstir (Length of stirrups along X) = 1460.00
              Astir (stirrups area) = 78.53982
              Asec (section area) = 237500.00
        -------------------------------------------------------------------
              s = 100.00
             fywe = 555.55
             fce  = 20.00
          From ((5.A5), TBDY), TBDY:  cc = 0.002
              c  = confinement factor = 1.00
        y1 = 0.00129669
       sh1 = 0.0044814
      ft1 = 373.4467
      fy1 = 311.2056
       su1 = 0.00512
          using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
          and also multiplied by the shear_factor according to 15.7.1.4, with
          Shear_factor = 1.00
          lo/lou,min = lb/ld = 0.30
           su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
          From table 5A.1, TBDY: esu1_nominal = 0.08,
          For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
          characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
           y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
            with fs1 = fs = 311.2056
            with Es1 = Es = 200000.00
        y2 = 0.00129669
       sh2 = 0.0044814
      ft2 = 373.4467
      fy2 = 311.2056
       su2 = 0.00512
          using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
          and also multiplied by the shear_factor according to 15.7.1.4, with
          Shear_factor = 1.00
          lo/lou,min = lb/lb,min = 0.30
           su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
          From table 5A.1, TBDY: esu2_nominal = 0.08,
          For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
          characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
           y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
            with fs2 = fs = 311.2056
            with Es2 = Es = 200000.00
        yv = 0.00129669
       shv = 0.0044814
      ftv = 373.4467
      fyv = 311.2056
       suv = 0.00512
          using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
          and also multiplied by the shear_factor according to 15.7.1.4, with
          Shear_factor = 1.00
          lo/lou,min = lb/ld = 0.30
           suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
          From table 5A.1, TBDY: esuv_nominal = 0.08,
          considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
          For calculation of esuv_nominal and  yv, shv,ftv,fyv, it is considered
          characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
           y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
            with fsv = fs = 311.2056
            with Esv = Es = 200000.00
         1 = Asl,ten/(b*d)*(fs1/fc) = 0.03861577
         2 = Asl,com/(b*d)*(fs2/fc) = 0.08132715
         v = Asl,mid/(b*d)*(fsv/fc) = 0.07196575
and confined core properties:
   b = 540.00
```

```
   d = 527.00
   d' = 13.00
  fcc (5A.2, TBDY) = 20.00
   cc (5A.5, TBDY) = 0.002
      c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.0453489
    2 = Asl,com/(b*d)*(fs2/fc) = 0.09550753
    v = Asl,mid/(b*d)*(fsv/fc) = 0.08451386
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.16341054
Mu = MRc (4.14) = 2.3955E+008
 u =   su (4.1) = 1.0987588E-005
------------------------------------------------------------
```

Calculation of ratio lb/ld

```
------------------------------------------------------------
```

Inadequate Lap Length with lb/ld = 0.30

```
----------------------------------------------------------------
----------------------------------------------------------------
----------------------------------------------------------------
```

Calculation of Mu2+

```
----------------------------------------------------------------


----------------------------------------------------------------
```

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
```
  u = 1.3683047E-005
Mu = 4.1999E+008
----------------------------------------------------------------
```
with full section properties:
```
  b = 250.00
  d = 557.00
  d' = 43.00
  v = 0.0031899
    N = 8883.864
  fc = 20.00
   co (5A.5, TBDY) = 0.002
  Final value of  cu:  cu* = shear_factor * Max( cu, cc) = 0.00768077
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY:  cu = 0.00768077
      we (5.4c) = 0.01092426
     ase = Max((((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
              is calculated as the area of core enclosed by the center lines of the perimeter hoops.
        Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
              is calculated by reducing all the dimensions of the area Aconf,max by a length
              equal to half the clear spacing between hoops.
        AnoConf = 105733.333 is the unconfined core area which is equal to  bi2/6 as defined at (A.2).
      psh,min = Min(psh,x , psh,y) = 0.00482813
     Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
     ----------------------------------------------------------------
       psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
          Lstir (Length of stirrups along Y) = 1460.00
          Astir (stirrups area) = 78.53982
          Asec (section area) = 237500.00
     ----------------------------------------------------------------
       psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
          Lstir (Length of stirrups along X) = 1460.00
```

```
          Astir (stirrups area) = 78.53982
          Asec (section area) = 237500.00

     -------------------------------------------------------------------
            s = 100.00
         fywe = 555.55
         fce  = 20.00
      From ((5.A5), TBDY), TBDY:  cc = 0.002
           c  = confinement factor = 1.00
    y1 = 0.00129669
   sh1 = 0.0044814
 ft1 = 373.4467
 fy1 = 311.2056
   su1 = 0.00512
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/ld = 0.30
      su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esu1_nominal = 0.08,
     For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
     characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
      with fs1 = fs = 311.2056
      with Es1 = Es = 200000.00
    y2 = 0.00129669
   sh2 = 0.0044814
 ft2 = 373.4467
 fy2 = 311.2056
   su2 = 0.00512
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/lb,min = 0.30
      su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esu2_nominal = 0.08,
     For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
     characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
      with fs2 = fs = 311.2056
      with Es2 = Es = 200000.00
    yv = 0.00129669
   shv = 0.0044814
 ftv = 373.4467
 fyv = 311.2056
   suv = 0.00512
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/ld = 0.30
      suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esuv_nominal = 0.08,
     considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
     For calculation of esuv_nominal and  yv, shv,ftv,fyv, it is considered
     characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
      with fsv = fs = 311.2056
      with Esv = Es = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.19518516
    2 = Asl,com/(b*d)*(fs2/fc) = 0.09267785
    v = Asl,mid/(b*d)*(fsv/fc) = 0.17271781
 and confined core properties:
   b = 190.00
   d = 527.00
   d' = 13.00
   fcc (5A.2, TBDY) = 20.00
    cc (5A.5, TBDY) = 0.002
      c  = confinement factor = 1.00
```

1 = Asl,ten/(b*d)*(fs1/fc) = 0.27144246
 2 = Asl,com/(b*d)*(fs2/fc) = 0.12888635
 v = Asl,mid/(b*d)*(fsv/fc) = 0.24019729
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
 su (4.8) = 0.32821245
Mu = MRc (4.15) = 4.1999E+008
 u =   su (4.1) = 1.3683047E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
 u = 1.0987588E-005
Mu = 2.3955E+008
----
with full section properties:
 b = 600.00
 d = 557.00
 d' = 43.00
 v = 0.00132912
   N = 8883.864
 fc = 20.00
  co (5A.5, TBDY) = 0.002
 Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
   The Shear_factor is considered equal to 1 (pure moment strength)
   From (5.4b), TBDY: cu = 0.00768077
    we (5.4c) = 0.01092426
    ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
       The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
       of the rectangular sections confinement, which is expressed by (5.4d).
       The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
       "Theoretical Stress-Strain Model for Confined Concrete."
       J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
       Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
             is calculated as the area of core enclosed by the center lines of the perimeter hoops.
       Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
             is calculated by reducing all the dimensions of the area Aconf,max by a length
             equal to half the clear spacing between hoops.
       AnoConf = 105733.333 is the unconfined core area which is equal to   bi2/6 as defined at (A.2).
    psh,min = Min(psh,x , psh,y) = 0.00482813
   Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
   ----
      psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
         Lstir (Length of stirrups along Y) = 1460.00
         Astir (stirrups area) = 78.53982
         Asec (section area) = 237500.00
   ----
      psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
         Lstir (Length of stirrups along X) = 1460.00
         Astir (stirrups area) = 78.53982
         Asec (section area) = 237500.00

```
        s = 100.00
      fywe = 555.55
       fce = 20.00
   From ((5.A5), TBDY), TBDY:  cc = 0.002
       c = confinement factor = 1.00
  y1 = 0.00129669
  sh1 = 0.0044814
 ft1 = 373.4467
 fy1 = 311.2056
  su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
     su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
      with fs1 = fs = 311.2056
      with Es1 = Es = 200000.00
  y2 = 0.00129669
  sh2 = 0.0044814
 ft2 = 373.4467
 fy2 = 311.2056
  su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.30
     su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
      with fs2 = fs = 311.2056
      with Es2 = Es = 200000.00
  yv = 0.00129669
  shv = 0.0044814
 ftv = 373.4467
 fyv = 311.2056
  suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
     suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and  yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
      with fsv = fs = 311.2056
      with Esv = Es = 200000.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.03861577
   2 = Asl,com/(b*d)*(fs2/fc) = 0.08132715
   v = Asl,mid/(b*d)*(fsv/fc) = 0.07196575
 and confined core properties:
  b = 540.00
  d = 527.00
  d' = 13.00
  fcc (5A.2, TBDY) = 20.00
   cc (5A.5, TBDY) = 0.002
      c = confinement factor = 1.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.0453489
   2 = Asl,com/(b*d)*(fs2/fc) = 0.09550753
   v = Asl,mid/(b*d)*(fsv/fc) = 0.08451386
```

Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.16341054
Mu = MRc (4.14) = 2.3955E+008
 u = su (4.1) = 1.0987588E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 424229.688

Calculation of Shear Strength at edge 1, Vr1 = 424229.688
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 424229.688
  knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

    = 1 (normal-weight concrete)
  fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
     Mu = 47.14131
     Vu = 0.00016213
  d = 0.8*h = 480.00
  Nu = 8883.864
  Ag = 150000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 474724.809
  where:
  Vs1 = 335099.865 is calculated for section web, with:
    d = 480.00
    Av = 157079.633
    fy = 444.44
    s = 100.00
  Vs1 is multiplied by Col1 = 1.00
    s/d = 0.20833333
  Vs2 = 139624.944 is calculated for section flange, with:
    d = 200.00
    Av = 157079.633
    fy = 444.44
    s = 100.00
  Vs2 is multiplied by Col2 = 1.00
    s/d = 0.50
  Vf ((11-3)-(11.4), ACI 440) = 0.00
  From (11-11), ACI 440: Vs + Vf <= 356502.845
    bw = 250.00

Calculation of Shear Strength at edge 2, Vr2 = 424229.688
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 424229.688
  knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

    = 1 (normal-weight concrete)
  fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00

Mu = 47.14134
Vu = 0.00016213
d = 0.8*h = 480.00
Nu = 8883.864
Ag = 150000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 474724.809
where:
Vs1 = 335099.865 is calculated for section web, with:
  d = 480.00
  Av = 157079.633
  fy = 444.44
  s = 100.00
Vs1 is multiplied by   Col1 = 1.00
  s/d = 0.20833333
Vs2 = 139624.944 is calculated for section flange, with:
  d = 200.00
  Av = 157079.633
  fy = 444.44
  s = 100.00
Vs2 is multiplied by   Col2 = 1.00
  s/d = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 356502.845
  bw = 250.00

End Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rclcs

Constant Properties

Knowledge Factor,   = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Existing material: Steel Strength, fs = 1.25*fsm = 555.55
##
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = 0.00016213
EDGE -B-
Shear Force, Vb = -0.00016213
BOTH EDGES
Axial Force, F = -8883.864
Longitudinal Reinforcement Area Distribution (in 2 divisions)
    -Tension: Aslt = 0.00
  -Compression: Aslc = 4121.77
Longitudinal Reinforcement Area Distribution (in 3 divisions)
    -Tension: Asl,ten = 1746.726
  -Compression: Asl,com = 829.3805
   -Middle: Asl,mid = 1545.664

Calculation of Shear Capacity ratio , Ve/Vr = 0.66001051
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 279996.052
with
Mpr1 = Max(Mu1+ , Mu1-) = 4.1999E+008
  Mu1+ = 4.1999E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
  Mu1- = 2.3955E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 4.1999E+008
  Mu2+ = 4.1999E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
  Mu2- = 2.3955E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
  u = 1.3683047E-005
Mu = 4.1999E+008
----
with full section properties:
  b = 250.00
  d = 557.00
  d' = 43.00
  v = 0.0031899
    N = 8883.864
  fc = 20.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00768077
      we (5.4c) = 0.01092426
     ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
           is calculated as the area of core enclosed by the center lines of the perimeter hoops.
        Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
           is calculated by reducing all the dimensions of the area Aconf,max by a length
           equal to half the clear spacing between hoops.

AnoConf = 105733.333 is the unconfined core area which is equal to bi2/6 as defined at (A.2).
psh,min = Min(psh,x , psh,y) = 0.00482813
Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

----

psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along Y) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00

----

psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00

----

s = 100.00
fywe = 555.55
fce = 20.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00129669
sh1 = 0.0044814
ft1 = 373.4467
fy1 = 311.2056
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 311.2056
with Es1 = Es = 200000.00
y2 = 0.00129669
sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 311.2056
with Es2 = Es = 200000.00
yv = 0.00129669
shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.

with fsv = fs = 311.2056
        with Esv = Es = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.19518516
    2 = Asl,com/(b*d)*(fs2/fc) = 0.09267785
    v = Asl,mid/(b*d)*(fsv/fc) = 0.17271781
and confined core properties:
   b = 190.00
   d = 527.00
   d' = 13.00
   fcc (5A.2, TBDY) = 20.00
    cc (5A.5, TBDY) = 0.002
       c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.27144246
    2 = Asl,com/(b*d)*(fs2/fc) = 0.12888635
    v = Asl,mid/(b*d)*(fsv/fc) = 0.24019729
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
 su (4.8) = 0.32821245
Mu = MRc (4.15) = 4.1999E+008
  u =   su (4.1) = 1.3683047E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.0987588E-005
Mu = 2.3955E+008
----
with full section properties:
   b = 600.00
   d = 557.00
   d' = 43.00
   v = 0.00132912
     N = 8883.864
   fc = 20.00
    co (5A.5, TBDY) = 0.002
   Final value of   cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
      The Shear_factor is considered equal to 1 (pure moment strength)
      From (5.4b), TBDY: cu = 0.00768077
        we (5.4c) = 0.01092426
         ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
            The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
            of the rectangular sections confinement, which is expressed by (5.4d).
            The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
            "Theoretical Stress-Strain Model for Confined Concrete."
            J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
            Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
                    is calculated as the area of core enclosed by the center lines of the perimeter hoops.
            Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
                    is calculated by reducing all the dimensions of the area Aconf,max by a length
                    equal to half the clear spacing between hoops.
            AnoConf = 105733.333 is the unconfined core area which is equal to   bi2/6 as defined at (A.2).
            psh,min = Min(psh,x , psh,y) = 0.00482813
         Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without

earthquake detailing (90° closed stirrups)

```
      -------------------------------------------------------------------
      psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
         Lstir (Length of stirrups along Y) = 1460.00
         Astir (stirrups area) = 78.53982
         Asec (section area) = 237500.00
      -------------------------------------------------------------------
      psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
         Lstir (Length of stirrups along X) = 1460.00
         Astir (stirrups area) = 78.53982
         Asec (section area) = 237500.00
      -------------------------------------------------------------------
         s = 100.00
       fywe = 555.55
        fce = 20.00
    From ((5.A5), TBDY), TBDY:  cc = 0.002
         c = confinement factor = 1.00
   y1 = 0.00129669
  sh1 = 0.0044814
 ft1 = 373.4467
 fy1 = 311.2056
  su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
     su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
      with fs1 = fs = 311.2056
      with Es1 = Es = 200000.00
   y2 = 0.00129669
  sh2 = 0.0044814
 ft2 = 373.4467
 fy2 = 311.2056
  su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.30
     su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
      with fs2 = fs = 311.2056
      with Es2 = Es = 200000.00
   yv = 0.00129669
  shv = 0.0044814
 ftv = 373.4467
 fyv = 311.2056
  suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
     suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and  yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
      with fsv = fs = 311.2056
      with Esv = Es = 200000.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.03861577
```

2 = Asl,com/(b*d)*(fs2/fc) = 0.08132715
v = Asl,mid/(b*d)*(fsv/fc) = 0.07196575
and confined core properties:
  b = 540.00
  d = 527.00
  d' = 13.00
  fcc (5A.2, TBDY) = 20.00
   cc (5A.5, TBDY) = 0.002
      c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.0453489
    2 = Asl,com/(b*d)*(fs2/fc) = 0.09550753
    v = Asl,mid/(b*d)*(fsv/fc) = 0.08451386
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.16341054
Mu = MRc (4.14) = 2.3955E+008
  u =   su (4.1) = 1.0987588E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.3683047E-005
Mu = 4.1999E+008
----
with full section properties:
  b = 250.00
  d = 557.00
  d' = 43.00
  v = 0.0031899
    N = 8883.864
  fc = 20.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00768077
      we (5.4c) = 0.01092426
      ase = Max(((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
         The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
         of the rectangular sections confinement, which is expressed by (5.4d).
         The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
         "Theoretical Stress-Strain Model for Confined Concrete."
         J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
         Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
                is calculated as the area of core enclosed by the center lines of the perimeter hoops.
         Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
                is calculated by reducing all the dimensions of the area Aconf,max by a length
                equal to half the clear spacing between hoops.
         AnoConf = 105733.333 is the unconfined core area which is equal to   bi2/6 as defined at (A.2).
      psh,min = Min(psh,x , psh,y) = 0.00482813
    Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
      ----
         psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
            Lstir (Length of stirrups along Y) = 1460.00
            Astir (stirrups area) = 78.53982

Asec (section area) = 237500.00
----
psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
Lstir (Length of stirrups along X) = 1460.00
Astir (stirrups area) = 78.53982
Asec (section area) = 237500.00
----
s = 100.00
fywe = 555.55
fce = 20.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00129669
sh1 = 0.0044814
ft1 = 373.4467
fy1 = 311.2056
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs1 = fs = 311.2056
with Es1 = Es = 200000.00
y2 = 0.00129669
sh2 = 0.0044814
ft2 = 373.4467
fy2 = 311.2056
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fs2 = fs = 311.2056
with Es2 = Es = 200000.00
yv = 0.00129669
shv = 0.0044814
ftv = 373.4467
fyv = 311.2056
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
with fsv = fs = 311.2056
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.19518516
2 = Asl,com/(b*d)*(fs2/fc) = 0.09267785
v = Asl,mid/(b*d)*(fsv/fc) = 0.17271781
and confined core properties:
b = 190.00
d = 527.00

d' = 13.00
fcc (5A.2, TBDY) = 20.00
  cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.27144246
  2 = Asl,com/(b*d)*(fs2/fc) = 0.12888635
  v = Asl,mid/(b*d)*(fsv/fc) = 0.24019729
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
 su (4.8) = 0.32821245
Mu = MRc (4.15) = 4.1999E+008
 u =   su (4.1) = 1.3683047E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
 u = 1.0987588E-005
Mu = 2.3955E+008
----
with full section properties:
 b = 600.00
 d = 557.00
 d' = 43.00
 v = 0.00132912
   N = 8883.864
 fc = 20.00
  co (5A.5, TBDY) = 0.002
 Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00768077
   The Shear_factor is considered equal to 1 (pure moment strength)
   From (5.4b), TBDY: cu = 0.00768077
     we (5.4c) = 0.01092426
     ase = Max((((Aconf,max-AnoConf)/Aconf,max)*(Aconf,min/Aconf,max),0) = 0.27151783
       The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
       of the rectangular sections confinement, which is expressed by (5.4d).
       The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
       "Theoretical Stress-Strain Model for Confined Concrete."
       J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
       Aconf,max = 169100.00 is the confined core area at levels of member with hoops and
             is calculated as the area of core enclosed by the center lines of the perimeter hoops.
       Aconf,min = 122525.00 is the confined core area at midway between the levels of hoops and
             is calculated by reducing all the dimensions of the area Aconf,max by a length
             equal to half the clear spacing between hoops.
       AnoConf = 105733.333 is the unconfined core area which is equal to   bi2/6 as defined at (A.2).
     psh,min = Min(psh,x , psh,y) = 0.00482813
   Expression ((5.4d), TBDY) for psh,min has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

     ----
       psh,x ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813
         Lstir (Length of stirrups along Y) = 1460.00
         Astir (stirrups area) = 78.53982
         Asec (section area) = 237500.00
     ----
       psh,y ((5.4d), TBDY) = Lstir*Astir/(Asec*s) = 0.00482813

```
            Lstir (Length of stirrups along X) = 1460.00
            Astir (stirrups area) = 78.53982
            Asec (section area) = 237500.00

     ----------------------------------------------------------------
            s = 100.00
         fywe = 555.55
          fce = 20.00
      From ((5.A5), TBDY):  cc = 0.002
            c = confinement factor = 1.00
   y1 = 0.00129669
  sh1 = 0.0044814
 ft1 = 373.4467
 fy1 = 311.2056
  su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
      su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and   y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
      with fs1 = fs = 311.2056
      with Es1 = Es = 200000.00
   y2 = 0.00129669
  sh2 = 0.0044814
 ft2 = 373.4467
 fy2 = 311.2056
  su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.30
      su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and   y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
      with fs2 = fs = 311.2056
      with Es2 = Es = 200000.00
   yv = 0.00129669
  shv = 0.0044814
 ftv = 373.4467
 fyv = 311.2056
  suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
      suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and   yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE41-17.
      with fsv = fs = 311.2056
      with Esv = Es = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.03861577
    2 = Asl,com/(b*d)*(fs2/fc) = 0.08132715
    v = Asl,mid/(b*d)*(fsv/fc) = 0.07196575
 and confined core properties:
   b = 540.00
   d = 527.00
   d' = 13.00
  fcc (5A.2, TBDY) = 20.00
   cc (5A.5, TBDY) = 0.002
```

```
    c  = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.0453489
    2 = Asl,com/(b*d)*(fs2/fc) = 0.09550753
    v = Asl,mid/(b*d)*(fsv/fc) = 0.08451386
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.16341054
Mu = MRc (4.14) = 2.3955E+008
  u =   su (4.1) = 1.0987588E-005
-------------------------------------------------------------

Calculation of ratio lb/ld
-------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 424229.688
---------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 424229.688
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 424229.688
  knl = 1 (zero step-static loading)
-------------------------------------------------------------
NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+  f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
-------------------------------------------------------------
    = 1 (normal-weight concrete)
  fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
     Mu = 47.13723
     Vu = 0.00016213
  d = 0.8*h = 480.00
  Nu = 8883.864
  Ag = 150000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 474724.809
  where:
  Vs1 = 139624.944 is calculated for section web, with:
   d = 200.00
   Av = 157079.633
   fy = 444.44
   s = 100.00
  Vs1 is multiplied by   Col1 = 1.00
    s/d = 0.50
  Vs2 = 335099.865 is calculated for section flange, with:
   d = 480.00
   Av = 157079.633
   fy = 444.44
   s = 100.00
  Vs2 is multiplied by   Col2 = 1.00
    s/d = 0.20833333
  Vf ((11-3)-(11.4), ACI 440) = 0.00
  From (11-11), ACI 440: Vs + Vf <= 356502.845
    bw = 250.00
-------------------------------------------------------------

---------------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 424229.688
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 424229.688
  knl = 1 (zero step-static loading)
-------------------------------------------------------------
NOTE: In expression (10-3) 'Vs' is replaced by 'Vs+  f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
```

```
----------------------------------------------------------------
   = 1 (normal-weight concrete)
 fc' = 20.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
 M/Vd = 4.00
    Mu = 47.13721
    Vu = 0.00016213
 d = 0.8*h = 480.00
 Nu = 8883.864
 Ag = 150000.00
 From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 474724.809
 where:
 Vs1 = 139624.944 is calculated for section web, with:
    d = 200.00
    Av = 157079.633
    fy = 444.44
    s = 100.00
 Vs1 is multiplied by   Col1 = 1.00
    s/d = 0.50
 Vs2 = 335099.865 is calculated for section flange, with:
    d = 480.00
    Av = 157079.633
    fy = 444.44
    s = 100.00
 Vs2 is multiplied by   Col2 = 1.00
    s/d = 0.20833333
 Vf ((11-3)-(11.4), ACI 440) = 0.00
 From (11-11), ACI 440: Vs + Vf <= 356502.845
    bw = 250.00
----------------------------------------------------------------
----------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column LC1 of floor 1
At local axis: 2


----------------------------------------------------------------


Start Of Calculation of Chord Rotation Capacity for element: column LC1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rclcs

Constant Properties
----------------------------------------------------------------
Knowledge Factor,   = 1.00
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
Max Height, Hmax = 600.00
Min Height, Hmin = 250.00
Max Width, Wmax = 600.00
Min Width, Wmin = 250.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lb/ld = 0.30
No FRP Wrapping
----------------------------------------------------------------

Stepwise Properties
```

Bending Moment, M = 135615.782
Shear Force, V2 = 3517.163
Shear Force, V3 = -121.1248
Axial Force, F = -9523.595
Longitudinal Reinforcement Area Distribution (in 2 divisions)
     -Tension: Aslt = 0.00
   -Compression: Aslc = 4121.77
Longitudinal Reinforcement Area Distribution (in 3 divisions)
     -Tension: Asl,ten = 1746.726
   -Compression: Asl,com = 829.3805
     -Middle: Asl,mid = 1545.664
Mean Diameter of Tension Reinforcement, DbL = 17.71429

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = $*$ θu = 0.03062741
 θu = θy + θp = 0.03062741

 - Calculation of θy -

 θy = (My*Ls/3)/EIeff = 0.00062741 ((4.29),Biskinis Phd))
  My = 2.6302E+008
  Ls = M/V (with Ls > 0.1*L and Ls < 2*L) = 300.00
  From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 4.1921E+013
     factor = 0.30
        Ag = 237500.00
        fc' = 20.00
        N = 9523.595
     Ec*Ig = 1.3974E+014

Calculation of Yielding Moment My

Calculation of θy and My according to Annex 7   -

 θy = Min(θy_ten, θy_com)
 θy_ten = 3.6310943E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 248.9644
    d = 557.00
    ϕy = 0.38451907
    A = 0.02987449
    B = 0.01925673
    with pt = 0.01254381
       pc = 0.00595605
       pv = 0.01109992
       N = 9523.595
       b = 250.00
       " = 0.07719928
 θy_comp = 8.0244262E-006
 with fc = 20.00
    Ec = 21019.039
    ϕy = 0.38319556
    A = 0.02940012
    B = 0.01898202
    with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

- Calculation of p -

From table 10-8: p = 0.03
with:
 - Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
   shear control ratio VyE/VColOE = 0.66001051
   d = 557.00
   s = 0.00
     t = Av/(bw*s) + 2*tf/bw*(ffe/fs) = Av*Lstir/(Ag*s) + 2*tf/bw*(ffe/fs) = 0.00
   Av = 78.53982, is the area of every stirrup
   Lstir = 1460.00, is the total Length of all stirrups parallel to loading (shear) direction
   The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
   where f = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises f to steel strength
   All these variables have already been given in Shear control ratio calculation.
     NUD = 9523.595
     Ag = 237500.00
     f'cE = 20.00
     fytE = fylE = 0.00
pl = Area_Tot_Long_Rein/(b*d) = 0.02959978
   b = 250.00
   d = 557.00
     f'cE = 20.00

End Of Calculation of Chord Rotation Capacity for element: column LC1 of floor 1
At local axis: 3
Integration Section: (b)