Detailed Member Calculations

Units: N & mm

Regulation: ASCE 41-17

Calculation No. 1
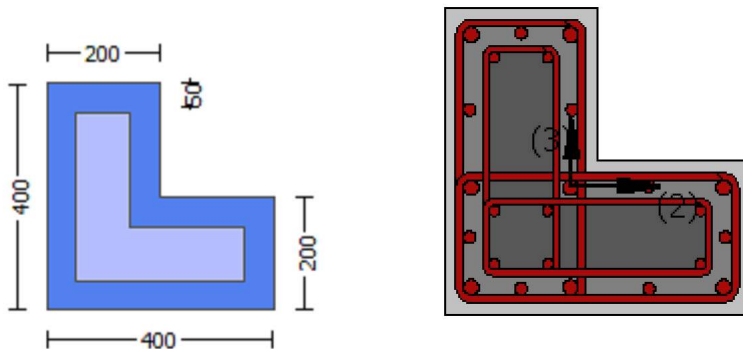
column C1, Floor 1

Limit State: Operational Level (data interpolation between analysis steps 50 and 51)

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (2)

Start Of Calculation of Shear Capacity for element: column JLC1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rcjlcs

Constant Properties

Knowledge Factor, = 0.90
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 12.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 19940.411
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, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 30.00
New material: Steel Strength, fs = fsm = 625.00
Existing Column
Existing material: Concrete Strength, fc = fcm = 18.00
Existing material: Steel Strength, fs = fsm = 500.00
###
Max Height, Hmax = 400.00
Min Height, Hmin = 200.00
Max Width, Wmax = 400.00
Min Width, Wmin = 200.00
Jacket Thickness, tj = 50.00
Cover Thickness, c = 15.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min = lb/ld >=1)
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -3.4056E+008
Shear Force, Va = -97644.268
EDGE -B-
Bending Moment, Mb = -7.2803E+007
Shear Force, Vb = 97644.268
BOTH EDGES
Axial Force, F = -1.8003E+006
Longitudinal Reinforcement Area Distribution (in 2 divisions)
       -Tension: Aslt = 2161.416
     -Compression: Aslc = 3191.858
Longitudinal Reinforcement Area Distribution (in 3 divisions)
       -Tension: Asl,ten = 2208.54
     -Compression: Asl,com = 1137.257
        -Middle: Asl,mid = 2007.478
Mean Diameter of Tension Reinforcement, DbL,ten = 16.60

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR =   *Vn = 258140.283
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 286822.537
   VCol = 286822.537
   knl = 1.00
       displacement_ductility_demand = 1.53373

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

    = 1 (normal-weight concrete)
   Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 16.66667, but fc^0.5 <=

8.3 MPa (22.5.3.1, ACI 318-14)

  M/Vd = 4.00

    Mu = 3.4056E+008

    Vu = 97644.268

  d = 0.8*h = 320.00

  Nu = 1.8003E+006

  Ag = 80000.00

  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 376991.118

  where:

  Vs,jacket = Vs,j1 + Vs,j2 = 376991.118

  Vs,j1 = 125663.706 is calculated for section web jacket, with:

    d = 160.00

    Av = 157079.633

    fy = 500.00

    s = 100.00

  Vs,j1 is multiplied by Col,j1 = 1.00

    s/d = 0.625

  Vs,j2 = 251327.412 is calculated for section flange jacket, with:

    d = 320.00

    Av = 157079.633

    fy = 500.00

    s = 100.00

  Vs,j2 is multiplied by Col,j2 = 1.00

    s/d = 0.3125

  Vs,core = Vs,c1 + Vs,c2 = 0.00

  Vs,c1 = 0.00 is calculated for section web core, with:

    d = 80.00

    Av = 100530.965

    fy = 400.00

    s = 250.00

  Vs,c1 is multiplied by Col,c1 = 0.00

    s/d = 3.125

  Vs,c2 = 0.00 is calculated for section flange core, with:

    d = 240.00

    Av = 100530.965

    fy = 400.00

    s = 250.00

  Vs,c2 is multiplied by Col,c2 = 0.00

    s/d = 1.04167

  Vf ((11-3)-(11.4), ACI 440) = 0.00

  From (11-11), ACI 440: Vs + Vf <= 173568.578

    bw = 200.00

----

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   = 0.02234349

 y = (My*Ls/3)/Eleff = 0.0145681 ((4.29),Biskinis Phd))

  My = 3.1266E+008

  Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3487.751

  From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 2.4951E+013

    factor = 0.70

     Ag = 120000.00

     Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00

     N = 1.8003E+006

    Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.5645E+013

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7 -

```
    y = Min( y_ten, y_com)
    y_ten = 1.9271316E-005
  with fy = 596.2441
      d = 367.00
      y = 0.57848146
      A = 0.11407012
      B = 0.08752406
       with pt = 0.0300891
           pc = 0.01549396
           pv = 0.02734983
           N = 1.8003E+006
           b = 200.00
           " = 0.08991826
    y_comp = 7.6825402E-006
  with fc = 30.00
      Ec = 25742.96
      y = 0.74398532
      A = 0.01446815
      B = 0.04638683
       with Es = 200000.00
-----------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
-----------------------------------------------------------
End Of Calculation of Shear Capacity for element: column JLC1 of floor 1
At local axis: 2
Integration Section: (a)


-----------------------------------------------------------
```
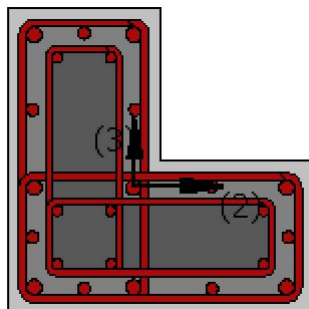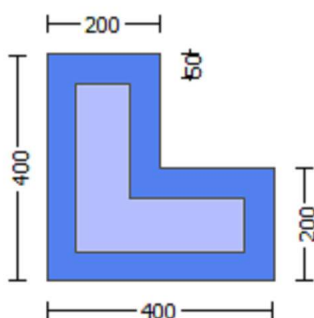
Calculation No. 2

column C1, Floor 1

Limit State: Operational Level (data interpolation between analysis steps 50 and 51)

Analysis: Uniform +X

Check: Chord rotation capacity (u)

Edge: Start

Local Axis: (2)

Start Of Calculation of Shear Capacity ratio for element: column JLC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcjlcs

Constant Properties

Knowledge Factor,   = 0.90
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 30.00
New material of Secondary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 18.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 500.00
Concrete Elasticity, Ec = 19940.411
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
Jacket
New material: Steel Strength, fs = 1.25*fsm = 781.25
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 625.00
###
Max Height, Hmax = 400.00
Min Height, Hmin = 200.00
Max Width, Wmax = 400.00
Min Width, Wmin = 200.00
Jacket Thickness, tj = 50.00
Cover Thickness, c = 15.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = 2.3476251E-006
EDGE -B-
Shear Force, Vb = -2.3476251E-006
BOTH EDGES
Axial Force, F = -1.8026E+006
Longitudinal Reinforcement Area Distribution (in 2 divisions)
     -Tension: Aslt = 0.00
     -Compression: Aslc = 5353.274
Longitudinal Reinforcement Area Distribution (in 3 divisions)
     -Tension: Asl,ten = 2208.54
    -Compression: Asl,com = 1137.257
       -Middle: Asl,mid = 2007.478

Calculation of Shear Capacity ratio , Ve/Vr = 1.44151
Member Controlled by Shear (Ve/Vr > 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 488890.189
with
Mpr1 = Max(Mu1+ , Mu1-) = 7.3334E+008
  Mu1+ = 7.3334E+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- = 6.3768E+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-) = 7.3334E+008
  Mu2+ = 7.3334E+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- = 6.3768E+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 = 4.2207094E-005
Mu = 7.3334E+008
----
with full section properties:
  b = 400.00
  d = 367.00
  d' = 33.00
  v = 0.40931126
   N = 1.8026E+006
  fc = 30.00
  εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.00925707
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.00925707
      ωwe (5.4c) = 0.0207149
      αse ((5.4d), TBDY) = (αse1*Aext+ αse2*Aint)/Asec = 0.33836562
        αse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
        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,max1 = 89600.00 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 external perimeter hoops.
        Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
           is calculated by reducing all the dimensions of the area Aconf,max1 by a length
           equal to half the clear spacing between external hoops.
        AnoConf1 = 43733.333 is the unconfined external core area which is equal to Σbi2/6 as defined at (A.2).
      αse2 (>=αse1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
        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,max2 = 45264.00 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 internal perimeter hoops.
        Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
           is calculated by reducing all the dimensions of the area Aconf,max2 by a length
           equal to half the clear spacing between internal hoops.
        AnoConf2 = 32309.333 is the unconfined internal core area which is equal to Σbi2/6 as defined at (A.2).
      ρsh,min*Fywe = Min(ρsh,x*Fywe , ρsh,y*Fywe) = 6.12205
    Expression (5.4d) for ρsh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

      ρsh_x*Fywe = ρsh1*Fywe1+ρs2*Fywe2 = 6.12205
      ρsh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678

Lstir1 (Length of stirrups along Y) = 1040.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
Lstir2 (Length of stirrups along Y) = 768.00
Astir2 (stirrups area) = 50.26548

----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
Lstir1 (Length of stirrups along X) = 1040.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
Lstir2 (Length of stirrups along X) = 768.00
Astir2 (stirrups area) = 50.26548

Asec = 120000.00
s1 = 100.00
s2 = 250.00
fywe1 = 781.25
fywe2 = 625.00
fce = 30.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.0025
sh1 = 0.008
ft1 = 898.293
fy1 = 748.5775
su1 = 0.032
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 = 1.00
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, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 748.5775
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 886.7403
fy2 = 738.9503
su2 = 0.032
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 = 1.00
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, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 738.9503
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 894.3662
fyv = 745.3052
suv = 0.032
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 = 1.00
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, ASCE 41-17.
   with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
   with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.37540035
  2 = Asl,com/(b*d)*(fs2/fc) = 0.19082108
  v = Asl,mid/(b*d)*(fsv/fc) = 0.33973286
and confined core properties:
  b = 360.00
  d = 347.00
  d' = 13.00
  fcc (5A.2, TBDY) = 30.00
   cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.44115251
  2 = Asl,com/(b*d)*(fs2/fc) = 0.22424379
  v = Asl,mid/(b*d)*(fsv/fc) = 0.39923778
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
  ' satisfies Eq. (4.4)
--->
v < s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
 cu (4.10) = 0.59761571
MRc (4.17) = 7.3334E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N, 1, 2, v normalised to bo*do, instead of b*d
  - - parameters of confined concrete, fcc, cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 *cu (4.11) = 0.62879536
MRo (4.18) = 4.5866E+008
MRo < 0.8*MRc
--->
 u = cu (unconfined full section) = 4.2207094E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

```
------------------------------------------------------------------------
------------------------------------------------------------------------
------------------------------------------------------------------------
Calculation of Mu1-
------------------------------------------------------------------------


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```

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 4.8346386E-005
Mu = 6.3768E+008
```
------------------------------------------------------------------------
```

with full section properties:
  b = 200.00
  d = 367.00
  d' = 33.00
  ν = 0.81862252
    N = 1.8026E+006
  fc = 30.00
  εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.00925707
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.00925707
      ωwe (5.4c) = 0.0207149
      αse ((5.4d), TBDY) = (αse1*Aext+αse2*Aint)/Asec = 0.33836562
        αse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
        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,max1 = 89600.00 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 external perimeter hoops.
        Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
              is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                equal to half the clear spacing between external hoops.
        AnoConf1 = 43733.333 is the unconfined external core area which is equal to Σbi2/6 as defined at (A.2).
      αse2 (>=αse1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
        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,max2 = 45264.00 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 internal perimeter hoops.
        Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
              is calculated by reducing all the dimensions of the area Aconf,max2 by a length
                equal to half the clear spacing between internal hoops.
        AnoConf2 = 32309.333 is the unconfined internal core area which is equal to Σbi2/6 as defined at (A.2).
      ρsh,min*Fywe = Min(ρsh,x*Fywe , ρsh,y*Fywe) = 6.12205
    Expression (5.4d) for ρsh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

        ρsh_x*Fywe = ρsh1*Fywe1+ρs2*Fywe2 = 6.12205
        ρsh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
          Lstir1 (Length of stirrups along Y) = 1040.00
          Astir1 (stirrups area) = 78.53982
        ρsh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
          Lstir2 (Length of stirrups along Y) = 768.00
          Astir2 (stirrups area) = 50.26548

        ρsh_y*Fywe = ρsh1*Fywe1+ρs2*Fywe2 = 6.12205
        ρsh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
          Lstir1 (Length of stirrups along X) = 1040.00
          Astir1 (stirrups area) = 78.53982
        ρsh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
          Lstir2 (Length of stirrups along X) = 768.00
          Astir2 (stirrups area) = 50.26548

```
----------------------------------------------------------------------
         Asec = 120000.00
           s1 = 100.00
           s2 = 250.00
        fywe1 = 781.25
        fywe2 = 625.00
         fce  = 30.00
     From ((5.A5), TBDY):  cc = 0.002
         c  = confinement factor = 1.00
   y1 = 0.0025
  sh1 = 0.008
  ft1 = 886.7403
  fy1 = 738.9503
   su1 = 0.032
     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 = 1.00
      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, ASCE 41-17.
       with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 738.9503
       with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
   y2 = 0.0025
  sh2 = 0.008
  ft2 = 898.293
  fy2 = 748.5775
   su2 = 0.032
     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 = 1.00
      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, ASCE 41-17.
       with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 748.5775
       with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
   yv = 0.0025
  shv = 0.008
  ftv = 894.3662
  fyv = 745.3052
   suv = 0.032
     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 = 1.00
      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, ASCE 41-17.
       with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
       with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.38164216
     2 = Asl,com/(b*d)*(fs2/fc) = 0.7508007
     v = Asl,mid/(b*d)*(fsv/fc) = 0.67946571
 and confined core properties:
   b = 160.00
   d = 347.00
   d' = 13.00
  fcc (5A.2, TBDY) = 30.00
   cc (5A.5, TBDY) = 0.002
```

c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.50454853
    2 = Asl,com/(b*d)*(fs2/fc) = 0.99259314
    v = Asl,mid/(b*d)*(fsv/fc) = 0.898285
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
  ' satisfies Eq. (4.4)
--->
v <   s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
 cu (4.10) = 0.52172715
MRc (4.17) = 6.3768E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
   - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
   - N,   1,   2,   v normalised to bo*do, instead of b*d
   - - parameters of confined concrete, fcc, cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 *cu (4.11) = 0.5604845
MRo (4.18) = 4.7738E+008
MRo < 0.8*MRc
--->
  u =   cu (unconfined full section) = 4.8346386E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 4.2207094E-005
Mu = 7.3334E+008
----
with full section properties:
  b = 400.00

```
d = 367.00
d' = 33.00
v = 0.40931126
   N = 1.8026E+006
fc = 30.00
 co (5A.5, TBDY) = 0.002
Final value of  cu:  cu* = shear_factor * Max( cu, cc) = 0.00925707
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY:  cu = 0.00925707
      we (5.4c) = 0.0207149
      ase ((5.4d), TBDY) = (ase1*Aext+ ase2*Aint)/Asec = 0.33836562
          ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
          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,max1 = 89600.00 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 external perimeter hoops.
          Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
                  is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                  equal to half the clear spacing between external hoops.
          AnoConf1 = 43733.333 is the unconfined external core area which is equal to  bi2/6 as defined at (A.2).
        ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
          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,max2 = 45264.00 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 internal perimeter hoops.
          Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
                  is calculated by reducing all the dimensions of the area Aconf,max2 by a length
                  equal to half the clear spacing between internal hoops.
          AnoConf2 = 32309.333 is the unconfined internal core area which is equal to  bi2/6 as defined at (A.2).
        psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
    Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
        ----------------------------------------------------------------
        psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
           Lstir1 (Length of stirrups along Y) = 1040.00
           Astir1 (stirrups area) = 78.53982
        psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
           Lstir2 (Length of stirrups along Y) = 768.00
           Astir2 (stirrups area) = 50.26548
        ----------------------------------------------------------------
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
           Lstir1 (Length of stirrups along X) = 1040.00
           Astir1 (stirrups area) = 78.53982
        psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
           Lstir2 (Length of stirrups along X) = 768.00
           Astir2 (stirrups area) = 50.26548
        ----------------------------------------------------------------
           Asec = 120000.00
           s1 = 100.00
           s2 = 250.00
         fywe1 = 781.25
         fywe2 = 625.00
         fce  = 30.00
      From ((5.A5), TBDY), TBDY:  cc = 0.002
          c  = confinement factor = 1.00
  y1 = 0.0025
 sh1 = 0.008
ft1 = 898.293
fy1 = 748.5775
```

su1 = 0.032
  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 = 1.00
   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, ASCE 41-17.
    with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 748.5775
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.0025
  sh2 = 0.008
 ft2 = 886.7403
 fy2 = 738.9503
  su2 = 0.032
  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 = 1.00
   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, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 738.9503
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.0025
  shv = 0.008
 ftv = 894.3662
 fyv = 745.3052
  suv = 0.032
  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 = 1.00
   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, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.37540035
  2 = Asl,com/(b*d)*(fs2/fc) = 0.19082108
  v = Asl,mid/(b*d)*(fsv/fc) = 0.33973286
and confined core properties:
  b = 360.00
  d = 347.00
  d' = 13.00
  fcc (5A.2, TBDY) = 30.00
   cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.44115251
   2 = Asl,com/(b*d)*(fs2/fc) = 0.22424379
   v = Asl,mid/(b*d)*(fsv/fc) = 0.39923778
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 not satisfied
--->
Case/Assumption Rejected.
--->

New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
  ' satisfies Eq. (4.4)
--->
v < $\varepsilon_{s,y1}$ - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
  ξ_{cu} (4.10) = 0.59761571
MRc (4.17) = 7.3334E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N, ξ_1, ξ_2, v normalised to bo*do, instead of b*d
  - - parameters of confined concrete, fcc, ε_{cc}, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
  ξ*cu (4.11) = 0.62879536
MRo (4.18) = 4.5866E+008
MRo < 0.8*MRc
--->
  ξ_u = ξ_{cu} (unconfined full section) = 4.2207094E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φ_u according to 4.1, Biskinis/Fardis 2013:
  φ_u = 4.8346386E-005
Mu = 6.3768E+008
----
with full section properties:
  b = 200.00
  d = 367.00
  d' = 33.00
  v = 0.81862252
    N = 1.8026E+006
  fc = 30.00
  ε_{co} (5A.5, TBDY) = 0.002
  Final value of ε_{cu}: ε_{cu}* = shear_factor * Max(ε_{cu}, ε_{cc}) = 0.00925707
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: ε_{cu} = 0.00925707
      ω_{we} (5.4c) = 0.0207149
      α_{se} ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.33836562
        ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization

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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,max1 = 89600.00 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 external perimeter hoops.
Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
   is calculated by reducing all the dimensions of the area Aconf,max1 by a length
   equal to half the clear spacing between external hoops.
AnoConf1 = 43733.333 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
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,max2 = 45264.00 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 internal perimeter hoops.
Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
   is calculated by reducing all the dimensions of the area Aconf,max2 by a length
   equal to half the clear spacing between internal hoops.
AnoConf2 = 32309.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
       ----
       psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
       psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
          Lstir1 (Length of stirrups along Y) = 1040.00
          Astir1 (stirrups area) = 78.53982
       psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
          Lstir2 (Length of stirrups along Y) = 768.00
          Astir2 (stirrups area) = 50.26548
       ----
       psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
       psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
          Lstir1 (Length of stirrups along X) = 1040.00
          Astir1 (stirrups area) = 78.53982
       psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
          Lstir2 (Length of stirrups along X) = 768.00
          Astir2 (stirrups area) = 50.26548

       Asec = 120000.00
       s1 = 100.00
       s2 = 250.00
     fywe1 = 781.25
     fywe2 = 625.00
     fce = 30.00
   From ((5.A5), TBDY), TBDY: cc = 0.002
       c = confinement factor = 1.00
  y1 = 0.0025
  sh1 = 0.008
 ft1 = 886.7403
 fy1 = 738.9503
  su1 = 0.032
   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 = 1.00
    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, ASCE 41-17.
    with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 738.9503
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.0025

sh2 = 0.008
ft2 = 898.293
fy2 = 748.5775
su2 = 0.032
  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 = 1.00
  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, ASCE 41-17.
  with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 748.5775
  with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 894.3662
fyv = 745.3052
suv = 0.032
  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 = 1.00
  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, ASCE 41-17.
  with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.38164216
2 = Asl,com/(b*d)*(fs2/fc) = 0.7508007
v = Asl,mid/(b*d)*(fsv/fc) = 0.67946571
and confined core properties:
b = 160.00
d = 347.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
  c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.50454853
2 = Asl,com/(b*d)*(fs2/fc) = 0.99259314
v = Asl,mid/(b*d)*(fsv/fc) = 0.898285
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
' satisfies Eq. (4.4)
--->
v < s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
cu (4.10) = 0.52172715
MRc (4.17) = 6.3768E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
 - b, d, d' replaced by geometric parameters of the core: bo, do, d'o

- N, 1, 2, v normalised to bo*do, instead of b*d
- - parameters of confined concrete, fcc, cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 *cu (4.11) = 0.5604845
MRo (4.18) = 4.7738E+008
MRo < 0.8*MRc
--->
 u = cu (unconfined full section) = 4.8346386E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 339150.739

Calculation of Shear Strength at edge 1, Vr1 = 339150.739
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
 VCol0 = 339150.739
 knl = 1 (zero step-static loading)

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

   = 1 (normal-weight concrete)
 Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
 M/Vd = 4.00
   Mu = 2.0345E+006
   Vu = 2.3476251E-006
 d = 0.8*h = 320.00
 Nu = 1.8026E+006
 Ag = 80000.00
 From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 471238.898
 where:
 Vs,jacket = Vs,j1 + Vs,j2 = 471238.898
  Vs,j1 = 314159.265 is calculated for section web jacket, with:
    d = 320.00
    Av = 157079.633
    fy = 625.00
    s = 100.00
  Vs,j1 is multiplied by Col,j1 = 1.00
    s/d = 0.3125
  Vs,j2 = 157079.633 is calculated for section flange jacket, with:
    d = 160.00
    Av = 157079.633
    fy = 625.00
    s = 100.00
  Vs,j2 is multiplied by Col,j2 = 1.00

```
      s/d = 0.625
  Vs,core = Vs,c1 + Vs,c2 = 0.00
   Vs,c1 = 0.00 is calculated for section web core, with:
     d = 240.00
     Av = 100530.965
     fy = 500.00
     s = 250.00
   Vs,c1 is multiplied by   Col,c1 = 0.00
     s/d = 1.04167
   Vs,c2 = 0.00 is calculated for section flange core, with:
     d = 80.00
     Av = 100530.965
     fy = 500.00
     s = 250.00
   Vs,c2 is multiplied by   Col,c2 = 0.00
     s/d = 3.125
  Vf ((11-3)-(11.4), ACI 440) = 0.00
  From (11-11), ACI 440: Vs + Vf <= 212577.225
     bw = 200.00
------------------------------------------------------------
-------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 339150.739
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 339150.739
  knl = 1 (zero step-static loading)
------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
------------------------------------------------------------
    = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
     Mu = 6739.685
     Vu = 2.3476251E-006
  d = 0.8*h = 320.00
  Nu = 1.8026E+006
  Ag = 80000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 471238.898
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 471238.898
  Vs,j1 = 314159.265 is calculated for section web jacket, with:
     d = 320.00
     Av = 157079.633
     fy = 625.00
     s = 100.00
  Vs,j1 is multiplied by   Col,j1 = 1.00
     s/d = 0.3125
  Vs,j2 = 157079.633 is calculated for section flange jacket, with:
     d = 160.00
     Av = 157079.633
     fy = 625.00
     s = 100.00
  Vs,j2 is multiplied by   Col,j2 = 1.00
     s/d = 0.625
  Vs,core = Vs,c1 + Vs,c2 = 0.00
   Vs,c1 = 0.00 is calculated for section web core, with:
     d = 240.00
     Av = 100530.965
     fy = 500.00
     s = 250.00
   Vs,c1 is multiplied by   Col,c1 = 0.00
     s/d = 1.04167
   Vs,c2 = 0.00 is calculated for section flange core, with:
     d = 80.00
     Av = 100530.965
     fy = 500.00
```

```
      s = 250.00
   Vs,c2 is multiplied by   Col,c2 = 0.00
      s/d = 3.125
   Vf ((11-3)-(11.4), ACI 440) = 0.00
   From (11-11), ACI 440: Vs + Vf <= 212577.225
      bw = 200.00
------------------------------------------------------------
------------------------------------------------------------
```

End Of Calculation of Shear Capacity ratio for element: column JLC1 of floor 1
At local axis: 3

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

Start Of Calculation of Shear Capacity ratio for element: column JLC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjlcs

Constant Properties
```
------------------------------------------------------------
```
Knowledge Factor,   = 0.90
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 30.00
New material of Secondary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 18.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 500.00
Concrete Elasticity, Ec = 19940.411
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
Jacket
New material: Steel Strength, fs = 1.25*fsm = 781.25
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 625.00
##
Max Height, Hmax = 400.00
Min Height, Hmin = 200.00
Max Width, Wmax = 400.00
Min Width, Wmin = 200.00
Jacket Thickness, tj = 50.00
Cover Thickness, c = 15.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

```

Stepwise Properties
```

```
At local axis: 2
EDGE -A-
Shear Force, Va = -3.6347847E-006
EDGE -B-
Shear Force, Vb = 3.6347847E-006
BOTH EDGES

Axial Force, F = -1.8026E+006
Longitudinal Reinforcement Area Distribution (in 2 divisions)
     -Tension: Aslt = 0.00
   -Compression: Aslc = 5353.274
Longitudinal Reinforcement Area Distribution (in 3 divisions)
     -Tension: Asl,ten = 1137.257
    -Compression: Asl,com = 2208.54
       -Middle: Asl,mid = 2007.478
----------------------------------------------------------
----------------------------------------------------------


Calculation of Shear Capacity ratio , Ve/Vr  =  1.18753
Member Controlled by Shear (Ve/Vr > 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 402750.026
with
Mpr1 =  Max(Mu1+ , Mu1-) = 6.0413E+008
   Mu1+ = 6.0413E+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- = 5.4612E+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-) = 6.0413E+008
   Mu2+ = 6.0413E+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- = 5.4612E+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 = 1.2613948E-005
Mu = 6.0413E+008
-------------------------------------------------------------------------
with full section properties:
  b = 400.00
  d = 367.00
  d' = 33.00
  v = 0.40931126
    N = 1.8026E+006
  fc = 30.00
   co (5A.5, TBDY) = 0.002
  Final value of  cu:  cu* = shear_factor * Max( cu, cc) = 0.00925707
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY:  cu = 0.00925707
        we (5.4c) = 0.0207149
       ase ((5.4d), TBDY) = (ase1*Aext+ ase2*Aint)/Asec = 0.33836562
          ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
          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,max1 = 89600.00 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 external perimeter hoops.
          Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
               is calculated by reducing all the dimensions of the area Aconf,max1 by a length
               equal to half the clear spacing between external hoops.
          AnoConf1 = 43733.333 is the unconfined external core area which is equal to  bi2/6 as defined at (A.2).
        ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
          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,max2 = 45264.00 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 internal perimeter hoops.
Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 32309.333 is the unconfined internal core area which is equal to  bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
Lstir1 (Length of stirrups along Y) = 1040.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
Lstir2 (Length of stirrups along Y) = 768.00
Astir2 (stirrups area) = 50.26548

------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
Lstir1 (Length of stirrups along X) = 1040.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
Lstir2 (Length of stirrups along X) = 768.00
Astir2 (stirrups area) = 50.26548

------------------------------------------------------------------
Asec = 120000.00
s1 = 100.00
s2 = 250.00
fywe1 = 781.25
fywe2 = 625.00
fce = 30.00
From ((5.A5), TBDY), TBDY:  cc = 0.002
c  = confinement factor = 1.00
y1 = 0.0025
sh1 = 0.008
ft1 = 886.7403
fy1 = 738.9503
su1 = 0.032
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 = 1.00
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, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 738.9503
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 898.293
fy2 = 748.5775
su2 = 0.032
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 = 1.00
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, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 748.5775
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025

shv = 0.008
ftv = 894.3662
fyv = 745.3052
suv = 0.032
  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 = 1.00
  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, ASCE 41-17.
  with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.19082108
2 = Asl,com/(b*d)*(fs2/fc) = 0.37540035
v = Asl,mid/(b*d)*(fsv/fc) = 0.33973286
and confined core properties:
  b = 360.00
  d = 347.00
  d' = 13.00
  fcc (5A.2, TBDY) = 30.00
  cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.22424379
  2 = Asl,com/(b*d)*(fs2/fc) = 0.44115251
  v = Asl,mid/(b*d)*(fsv/fc) = 0.39923778
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
 ' satisfies Eq. (4.4)
--->
v <  s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
 cu (4.10) = 0.37716748
MRc (4.17) = 7.0585E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N,  1,  2,  v normalised to bo*do, instead of b*d
  -  -  parameters of confined concrete, fcc,  cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied

```
--->
 *cu (4.11) = 0.4569298
MRo (4.18) = 6.0413E+008
--->
  u =   cu (4.2) = 1.2613948E-005
Mu = MRo
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
----------------------------------------------------------------------
----------------------------------------------------------------------
----------------------------------------------------------------------
Calculation of Mu1-
----------------------------------------------------------------------

----------------------------------------------------------------------
Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 3.1475172E-005
Mu = 5.4612E+008
----------------------------------------------------------------------
with full section properties:
  b = 200.00
  d = 367.00
  d' = 33.00
  v = 0.81862252
    N = 1.8026E+006
  fc = 30.00
   co (5A.5, TBDY) = 0.002
  Final value of  cu:  cu* = shear_factor * Max( cu, cc) = 0.00925707
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY:  cu = 0.00925707
      we (5.4c) = 0.0207149
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.33836562
        ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
        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,max1 = 89600.00 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 external perimeter hoops.
        Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
               is calculated by reducing all the dimensions of the area Aconf,max1 by a length
               equal to half the clear spacing between external hoops.
        AnoConf1 = 43733.333 is the unconfined external core area which is equal to  bi2/6 as defined at (A.2).
      ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
        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,max2 = 45264.00 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 internal perimeter hoops.
        Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
               is calculated by reducing all the dimensions of the area Aconf,max2 by a length
               equal to half the clear spacing between internal hoops.
        AnoConf2 = 32309.333 is the unconfined internal core area which is equal to  bi2/6 as defined at (A.2).
      psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
    Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
        ------------------------------------------------------------------
        psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
          Lstir1 (Length of stirrups along Y) = 1040.00
          Astir1 (stirrups area) = 78.53982
```

psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
    Lstir2 (Length of stirrups along Y) = 768.00
    Astir2 (stirrups area) = 50.26548
----
    psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
    psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
    Lstir1 (Length of stirrups along X) = 1040.00
    Astir1 (stirrups area) = 78.53982
    psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
    Lstir2 (Length of stirrups along X) = 768.00
    Astir2 (stirrups area) = 50.26548

    Asec = 120000.00
    s1 = 100.00
    s2 = 250.00
    fywe1 = 781.25
    fywe2 = 625.00
    fce = 30.00
From ((5.A5), TBDY), TBDY: cc = 0.002
    c = confinement factor = 1.00
y1 = 0.0025
sh1 = 0.008
ft1 = 898.293
fy1 = 748.5775
su1 = 0.032
  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 = 1.00
  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, ASCE 41-17.
  with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 748.5775
  with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 886.7403
fy2 = 738.9503
su2 = 0.032
  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 = 1.00
  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, ASCE 41-17.
  with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 738.9503
  with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 894.3662
fyv = 745.3052
suv = 0.032
  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 = 1.00
  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, ASCE 41-17.

with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.7508007
  2 = Asl,com/(b*d)*(fs2/fc) = 0.38164216
  v = Asl,mid/(b*d)*(fsv/fc) = 0.67946571
and confined core properties:
  b = 160.00
  d = 347.00
  d' = 13.00
  fcc (5A.2, TBDY) = 30.00
   cc (5A.5, TBDY) = 0.002
     c = confinement factor = 1.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.99259314
  2 = Asl,com/(b*d)*(fs2/fc) = 0.50454853
  v = Asl,mid/(b*d)*(fsv/fc) = 0.898285
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
  ' satisfies Eq. (4.4)
--->
v <   s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is not satisfied
--->
 cu (4.11) = 0.80138156
MRc (4.18) = 5.4612E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N, 1, 2, v normalised to bo*do, instead of b*d
  - - parameters of confined concrete, fcc, cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 *cu (4.11) = 0.80674817
MRo (4.18) = 2.8580E+008
MRo < 0.8*MRc
--->
  u =   cu (unconfined full section) = 3.1475172E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
  u = 1.2613948E-005
Mu = 6.0413E+008
----
with full section properties:
  b = 400.00
  d = 367.00
  d' = 33.00
  v = 0.40931126
    N = 1.8026E+006
  fc = 30.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00925707
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: cu = 0.00925707
       we (5.4c) = 0.0207149
       ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.33836562
          ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
          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,max1 = 89600.00 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 external perimeter hoops.
          Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
                  is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                  equal to half the clear spacing between external hoops.
          AnoConf1 = 43733.333 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
        ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
          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,max2 = 45264.00 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 internal perimeter hoops.
          Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
                  is calculated by reducing all the dimensions of the area Aconf,max2 by a length
                   equal to half the clear spacing between internal hoops.
          AnoConf2 = 32309.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
       psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
     Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
        ----
          psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
          psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
             Lstir1 (Length of stirrups along Y) = 1040.00
             Astir1 (stirrups area) = 78.53982
          psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
             Lstir2 (Length of stirrups along Y) = 768.00
             Astir2 (stirrups area) = 50.26548
        ----
          psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
          psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
             Lstir1 (Length of stirrups along X) = 1040.00
             Astir1 (stirrups area) = 78.53982
          psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
             Lstir2 (Length of stirrups along X) = 768.00
             Astir2 (stirrups area) = 50.26548

          Asec = 120000.00

```
              s1 = 100.00
              s2 = 250.00
           fywe1 = 781.25
           fywe2 = 625.00
            fce = 30.00
        From ((5.A5), TBDY), TBDY:  cc = 0.002
            c = confinement factor = 1.00
     y1 = 0.0025
    sh1 = 0.008
   ft1 = 886.7403
   fy1 = 738.9503
    su1 = 0.032
       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 = 1.00
        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, ASCE 41-17.
         with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 738.9503
         with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
     y2 = 0.0025
    sh2 = 0.008
   ft2 = 898.293
   fy2 = 748.5775
    su2 = 0.032
       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 = 1.00
        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, ASCE 41-17.
         with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 748.5775
         with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
     yv = 0.0025
    shv = 0.008
   ftv = 894.3662
   fyv = 745.3052
    suv = 0.032
       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 = 1.00
        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, ASCE 41-17.
         with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
         with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.19082108
     2 = Asl,com/(b*d)*(fs2/fc) = 0.37540035
     v = Asl,mid/(b*d)*(fsv/fc) = 0.33973286
 and confined core properties:
   b = 360.00
   d = 347.00
   d' = 13.00
   fcc (5A.2, TBDY) = 30.00
    cc (5A.5, TBDY) = 0.002
       c = confinement factor = 1.00
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.22424379
```

ρ2 = Asl,com/(b*d)*(fs2/fc) = 0.44115251
ρv = Asl,mid/(b*d)*(fsv/fc) = 0.39923778
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
  ' satisfies Eq. (4.4)
--->
v < εs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
εcu (4.10) = 0.37716748
MRc (4.17) = 7.0585E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
  - ε - parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ε*cu (4.11) = 0.4569298
MRo (4.18) = 6.0413E+008
--->
φu = εcu (4.2) = 1.2613948E-005
Mu = MRo

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 3.1475172E-005
Mu = 5.4612E+008
----
with full section properties:
  b = 200.00
  d = 367.00
  d' = 33.00
  v = 0.81862252

N = 1.8026E+006
fc = 30.00
 co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00925707
   The Shear_factor is considered equal to 1 (pure moment strength)
   From (5.4b), TBDY: cu = 0.00925707
     we (5.4c) = 0.0207149
     ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.33836562
        ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
        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,max1 = 89600.00 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 external perimeter hoops.
        Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
                is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                equal to half the clear spacing between external hoops.
        AnoConf1 = 43733.333 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
     ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
        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,max2 = 45264.00 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 internal perimeter hoops.
        Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
                is calculated by reducing all the dimensions of the area Aconf,max2 by a length
                equal to half the clear spacing between internal hoops.
        AnoConf2 = 32309.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
     psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
   Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
     ----
     psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
     psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
       Lstir1 (Length of stirrups along Y) = 1040.00
       Astir1 (stirrups area) = 78.53982
     psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
       Lstir2 (Length of stirrups along Y) = 768.00
       Astir2 (stirrups area) = 50.26548
     ----
     psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
     psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
       Lstir1 (Length of stirrups along X) = 1040.00
       Astir1 (stirrups area) = 78.53982
     psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
       Lstir2 (Length of stirrups along X) = 768.00
       Astir2 (stirrups area) = 50.26548

       Asec = 120000.00
       s1 = 100.00
       s2 = 250.00
     fywe1 = 781.25
     fywe2 = 625.00
     fce = 30.00
   From ((5.A5), TBDY), TBDY: cc = 0.002
       c = confinement factor = 1.00
  y1 = 0.0025
  sh1 = 0.008
 ft1 = 898.293
 fy1 = 748.5775
  su1 = 0.032
   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 = 1.00
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, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 748.5775
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 886.7403
fy2 = 738.9503
su2 = 0.032
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 = 1.00
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, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 738.9503
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 894.3662
fyv = 745.3052
suv = 0.032
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 = 1.00
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, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.7508007
2 = Asl,com/(b*d)*(fs2/fc) = 0.38164216
v = Asl,mid/(b*d)*(fsv/fc) = 0.67946571
and confined core properties:
b = 160.00
d = 347.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.99259314
2 = Asl,com/(b*d)*(fs2/fc) = 0.50454853
v = Asl,mid/(b*d)*(fsv/fc) = 0.898285
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
' satisfies Eq. (4.4)
--->

v < εs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is not satisfied
--->
εcu (4.11) = 0.80138156
MRc (4.18) = 5.4612E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N, μ1, μ2, ν normalised to bo*do, instead of b*d
  - σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ε*cu (4.11) = 0.80674817
MRo (4.18) = 2.8580E+008
MRo < 0.8*MRc
--->
εu = εcu (unconfined full section) = 3.1475172E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 339150.739

Calculation of Shear Strength at edge 1, Vr1 = 339150.739
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 339150.739
  knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

  λ = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
    Mu = 6.7415E+007
    Vu = 3.6347847E-006
  d = 0.8*h = 320.00
  Nu = 1.8026E+006
  Ag = 80000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 471238.898
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 471238.898
  Vs,j1 = 157079.633 is calculated for section web jacket, with:
    d = 160.00
    Av = 157079.633

fy = 625.00
      s = 100.00
   Vs,j1 is multiplied by   Col,j1 = 1.00
      s/d = 0.625
   Vs,j2 = 314159.265 is calculated for section flange jacket, with:
      d = 320.00
      Av = 157079.633
      fy = 625.00
      s = 100.00
   Vs,j2 is multiplied by   Col,j2 = 1.00
      s/d = 0.3125
   Vs,core = Vs,c1 + Vs,c2 = 0.00
   Vs,c1 = 0.00 is calculated for section web core, with:
      d = 80.00
      Av = 100530.965
      fy = 500.00
      s = 250.00
   Vs,c1 is multiplied by   Col,c1 = 0.00
      s/d = 3.125
   Vs,c2 = 0.00 is calculated for section flange core, with:
      d = 240.00
      Av = 100530.965
      fy = 500.00
      s = 250.00
   Vs,c2 is multiplied by   Col,c2 = 0.00
      s/d = 1.04167
   Vf ((11-3)-(11.4), ACI 440) = 0.00
   From (11-11), ACI 440: Vs + Vf <= 212577.225
      bw = 200.00

Calculation of Shear Strength at edge 2, Vr2 = 339150.739
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
   VCol0 = 339150.739
   knl = 1 (zero step-static loading)

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

    = 1 (normal-weight concrete)
   Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
   M/Vd = 4.00
      Mu = 5.3429E+007
      Vu = 3.6347847E-006
   d = 0.8*h = 320.00
   Nu = 1.8026E+006
   Ag = 80000.00
   From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 471238.898
   where:
   Vs,jacket = Vs,j1 + Vs,j2 = 471238.898
   Vs,j1 = 157079.633 is calculated for section web jacket, with:
      d = 160.00
      Av = 157079.633
      fy = 625.00
      s = 100.00
   Vs,j1 is multiplied by   Col,j1 = 1.00
      s/d = 0.625
   Vs,j2 = 314159.265 is calculated for section flange jacket, with:
      d = 320.00
      Av = 157079.633
      fy = 625.00
      s = 100.00
   Vs,j2 is multiplied by   Col,j2 = 1.00
      s/d = 0.3125
   Vs,core = Vs,c1 + Vs,c2 = 0.00
   Vs,c1 = 0.00 is calculated for section web core, with:

```
        d = 80.00
        Av = 100530.965
        fy = 500.00
        s = 250.00
    Vs,c1 is multiplied by   Col,c1 = 0.00
        s/d = 3.125
    Vs,c2 = 0.00 is calculated for section flange core, with:
        d = 240.00
        Av = 100530.965
        fy = 500.00
        s = 250.00
    Vs,c2 is multiplied by   Col,c2 = 0.00
        s/d = 1.04167
    Vf ((11-3)-(11.4), ACI 440) = 0.00
    From (11-11), ACI 440: Vs + Vf <= 212577.225
        bw = 200.00
```


End Of Calculation of Shear Capacity ratio for element: column JLC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column JLC1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rcjlcs

Constant Properties

Knowledge Factor,   = 0.90
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 30.00
New material of Secondary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 18.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 500.00
Concrete Elasticity, Ec = 19940.411
Steel Elasticity, Es = 200000.00
Max Height, Hmax = 400.00
Min Height, Hmin = 200.00
Max Width, Wmax = 400.00
Min Width, Wmin = 200.00
Jacket Thickness, tj = 50.00
Cover Thickness, c = 15.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lb/ld>=1)
No FRP Wrapping

Stepwise Properties

Bending Moment, M = 1.8819E+007
Shear Force, V2 = -97644.268
Shear Force, V3 = -30.34672
Axial Force, F = -1.8003E+006

Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 2161.416
    -Compression: Aslc = 3191.858
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 1137.257
    -Compression: Asl,com = 2208.54
        -Middle: Asl,mid = 2007.478
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten,jacket = 829.3805
    -Compression: Asl,com,jacket = 1746.726
        -Middle: Asl,mid,jacket = 1545.664
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten,core = 307.8761
    -Compression: Asl,com,core = 461.8141
        -Middle: Asl,mid,core = 461.8141
Mean Diameter of Tension Reinforcement, DbL = 16.80

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $\theta_{u,R}$ = $*$ θ_u = 0.02661509
 θ_u = θ_y + θ_p = 0.02957233

 - Calculation of θ_y -

 θ_y = (My*Ls/3)/EIeff = 0.02957233 ((4.29),Biskinis Phd))
 My = 3.6894E+008
 Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 6000.00
 From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 2.4951E+013
    factor = 0.70
       Ag = 120000.00
       Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00
       N = 1.8003E+006
    Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.5645E+013

Calculation of Yielding Moment My

Calculation of θ_y and My according to Annex 7 -

 θ_y = Min(θ_y_ten, θ_y_com)
 θ_y_ten = 1.6451936E-005
with fy = 596.2441
    d = 367.00
    ξ_y = 0.50624552
    A = 0.11407012
    B = 0.0742413
    with pt = 0.01549396
       pc = 0.0300891
       pv = 0.02734983
       N = 1.8003E+006
       b = 200.00
       " = 0.08991826
 θ_y_comp = 9.3157495E-006
with fc = 30.00
    Ec = 25742.96
    ξ_y = 0.61355204
    A = 0.01446815
    B = 0.03310406
     with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

- Calculation of ρ -

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 = 1.44151
  d = d_external = 367.00
  s = s_external = 100.00
- ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.00809358
  jacket: ρs1 = Av1*Lstir1/(s1*Ag) = 0.00680678
       Av1 = 78.53982, is the area of every stirrup parallel to loading (shear) direction
       Lstir1 = 1040.00, is the total Length of all stirrups parallel to loading (shear) direction
       s1 = 100.00
  core: ρs2 = Av2*Lstir2/(s2*Ag) = 0.0012868
       Av2 = 50.26548, is the area of every stirrup parallel to loading (shear) direction
       Lstir2 = 768.00, is the total Length of all stirrups parallel to loading (shear) direction
       s2 = 250.00
  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.
  For the normalisation fs of jacket is used.
   NUD = 1.8003E+006
   Ag = 120000.00
   f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 25.00
   fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein =
596.2441
   fytE = (fy_ext_Trans_Reinf* ρs1+fy_int_Trans_Reinf* ρs2)/(ρs1+ ρs2) = 605.1263
pl = Area_Tot_Long_Rein/(b*d) = 0.07293289
  b = 200.00
  d = 367.00
   f'cE = 25.00

End Of Calculation of Chord Rotation Capacity for element: column JLC1 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 50 and 51)

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (3)

Start Of Calculation of Shear Capacity for element: column JLC1 of floor 1
At local axis: 3
Integration Section: (a)
Section Type: rcjlcs

Constant Properties

Knowledge Factor,　= 0.90
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 12.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 19940.411
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, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 30.00
New material: Steel Strength, fs = fsm = 625.00
Existing Column
Existing material: Concrete Strength, fc = fcm = 18.00
Existing material: Steel Strength, fs = fsm = 500.00
##
Max Height, Hmax = 400.00
Min Height, Hmin = 200.00
Max Width, Wmax = 400.00
Min Width, Wmin = 200.00
Jacket Thickness, tj = 50.00
Cover Thickness, c = 15.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min = lb/ld >=1)
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = 1.8819E+007

Shear Force, Va = -30.34672
EDGE -B-
Bending Moment, Mb = 18804.004
Shear Force, Vb = 30.34672
BOTH EDGES
Axial Force, F = -1.8003E+006
Longitudinal Reinforcement Area Distribution (in 2 divisions)
    -Tension: Aslt = 2161.416
    -Compression: Aslc = 3191.858
Longitudinal Reinforcement Area Distribution (in 3 divisions)
    -Tension: Asl,ten = 1137.257
    -Compression: Asl,com = 2208.54
    -Middle: Asl,mid = 2007.478
Mean Diameter of Tension Reinforcement, DbL,ten = 16.80

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR =   *Vn = 258140.283
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 286822.537
  VCol = 286822.537
  knl = 1.00
    displacement_ductility_demand = 0.11729439

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

    = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 16.66667, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
    Mu = 1.8819E+007
    Vu = 30.34672
  d = 0.8*h = 320.00
  Nu = 1.8003E+006
  Ag = 80000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 376991.118
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 376991.118
  Vs,j1 = 251327.412 is calculated for section web jacket, with:
    d = 320.00
    Av = 157079.633
    fy = 500.00
    s = 100.00
  Vs,j1 is multiplied by   Col,j1 = 1.00
    s/d = 0.3125
  Vs,j2 = 125663.706 is calculated for section flange jacket, with:
    d = 160.00
    Av = 157079.633
    fy = 500.00
    s = 100.00
  Vs,j2 is multiplied by   Col,j2 = 1.00
    s/d = 0.625
  Vs,core = Vs,c1 + Vs,c2 = 0.00
  Vs,c1 = 0.00 is calculated for section web core, with:
    d = 240.00
    Av = 100530.965
    fy = 400.00
    s = 250.00
  Vs,c1 is multiplied by   Col,c1 = 0.00
    s/d = 1.04167
  Vs,c2 = 0.00 is calculated for section flange core, with:
    d = 80.00
    Av = 100530.965
    fy = 400.00
    s = 250.00
  Vs,c2 is multiplied by   Col,c2 = 0.00

```
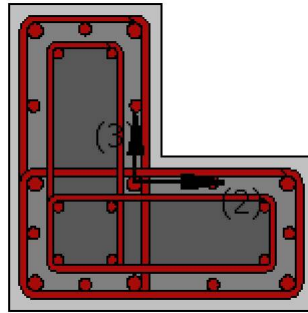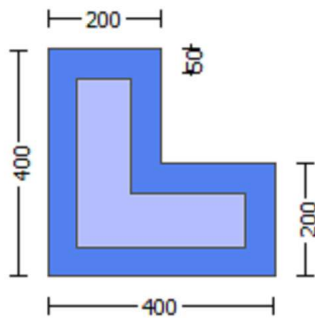     s/d = 3.125
   Vf ((11-3)-(11.4), ACI 440) = 0.00
   From (11-11), ACI 440: Vs + Vf <= 173568.578
     bw = 200.00
------------------------------------------------------------


------------------------------------------------------------
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    = 0.00346867
  y = (My*Ls/3)/EIeff = 0.02957233 ((4.29),Biskinis Phd))
  My = 3.6894E+008
  Ls = M/V (with Ls > 0.1*L and Ls < 2*L) = 6000.00
  From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 2.4951E+013
     factor = 0.70
        Ag = 120000.00
        Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00
        N = 1.8003E+006
     Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.5645E+013
------------------------------------------------------------
------------------------------------------------------------

Calculation of Yielding Moment My
------------------------------------------------------------
Calculation of   y and My according to Annex 7  -
------------------------------------------------------------
  y = Min(  y_ten,  y_com)
  y_ten = 1.6451936E-005
 with fy = 596.2441
     d = 367.00
      y = 0.50624552
     A = 0.11407012
     B = 0.0742413
      with pt = 0.01549396
          pc = 0.0300891
          pv = 0.02734983
          N = 1.8003E+006
          b = 200.00
          " = 0.08991826
   y_comp = 9.3157495E-006
 with fc = 30.00
     Ec = 25742.96
      y = 0.61355204
     A = 0.01446815
     B = 0.03310406
      with Es = 200000.00
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
------------------------------------------------------------
End Of Calculation of Shear Capacity for element: column JLC1 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 50 and 51)

Analysis: Uniform +X

Check: Chord rotation capacity (u)

Edge: Start

Local Axis: (3)

Start Of Calculation of Shear Capacity ratio for element: column JLC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcjlcs

Constant Properties

Knowledge Factor,   = 0.90
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 30.00
New material of Secondary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 18.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 500.00
Concrete Elasticity, Ec = 19940.411
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
Jacket
New material: Steel Strength, fs = 1.25*fsm = 781.25
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 625.00
##
Max Height, Hmax = 400.00
Min Height, Hmin = 200.00
Max Width, Wmax = 400.00
Min Width, Wmin = 200.00

Jacket Thickness, tj = 50.00
Cover Thickness, c = 15.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = 2.3476251E-006
EDGE -B-
Shear Force, Vb = -2.3476251E-006
BOTH EDGES
Axial Force, F = -1.8026E+006
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
   -Compression: Aslc = 5353.274
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 2208.54
   -Compression: Asl,com = 1137.257
       -Middle: Asl,mid = 2007.478

Calculation of Shear Capacity ratio , Ve/Vr = 1.44151
Member Controlled by Shear (Ve/Vr > 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 488890.189
with
Mpr1 = Max(Mu1+ , Mu1-) = 7.3334E+008
  Mu1+ = 7.3334E+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- = 6.3768E+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-) = 7.3334E+008
  Mu2+ = 7.3334E+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- = 6.3768E+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 = 4.2207094E-005
Mu = 7.3334E+008
----
with full section properties:
  b = 400.00
  d = 367.00
  d' = 33.00
  v = 0.40931126
     N = 1.8026E+006
  fc = 30.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00925707
     The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: cu = 0.00925707
  we (5.4c) = 0.0207149
   ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.33836562
    ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
    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,max1 = 89600.00 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 external perimeter hoops.
    Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
       is calculated by reducing all the dimensions of the area Aconf,max1 by a length
       equal to half the clear spacing between external hoops.
   AnoConf1 = 43733.333 is the unconfined external core area which is equal to   bi2/6 as defined at (A.2).
  ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
    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,max2 = 45264.00 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 internal perimeter hoops.
    Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
       is calculated by reducing all the dimensions of the area Aconf,max2 by a length
       equal to half the clear spacing between internal hoops.
   AnoConf2 = 32309.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
  psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
    ----
    psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
    psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
      Lstir1 (Length of stirrups along Y) = 1040.00
      Astir1 (stirrups area) = 78.53982
    psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
      Lstir2 (Length of stirrups along Y) = 768.00
      Astir2 (stirrups area) = 50.26548
    ----
    psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
    psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
      Lstir1 (Length of stirrups along X) = 1040.00
      Astir1 (stirrups area) = 78.53982
    psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
      Lstir2 (Length of stirrups along X) = 768.00
      Astir2 (stirrups area) = 50.26548

     Asec = 120000.00
     s1 = 100.00
     s2 = 250.00
    fywe1 = 781.25
    fywe2 = 625.00
    fce = 30.00
  From ((5.A5), TBDY), TBDY: cc = 0.002
    c = confinement factor = 1.00
 y1 = 0.0025
 sh1 = 0.008
ft1 = 898.293
fy1 = 748.5775
 su1 = 0.032
  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 = 1.00
  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, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 748.5775
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 886.7403
fy2 = 738.9503
su2 = 0.032
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 = 1.00
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, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 738.9503
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 894.3662
fyv = 745.3052
suv = 0.032
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 = 1.00
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, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.37540035
2 = Asl,com/(b*d)*(fs2/fc) = 0.19082108
v = Asl,mid/(b*d)*(fsv/fc) = 0.33973286
and confined core properties:
b = 360.00
d = 347.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.44115251
2 = Asl,com/(b*d)*(fs2/fc) = 0.22424379
v = Asl,mid/(b*d)*(fsv/fc) = 0.39923778
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
' satisfies Eq. (4.4)
--->
v < s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
cu (4.10) = 0.59761571

MRc (4.17) = 7.3334E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N, 1, 2, v normalised to bo*do, instead of b*d
  - - parameters of confined concrete, fcc, cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 *cu (4.11) = 0.62879536
MRo (4.18) = 4.5866E+008
MRo < 0.8*MRc
--->
  u = cu (unconfined full section) = 4.2207094E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
  u = 4.8346386E-005
Mu = 6.3768E+008
----
with full section properties:
  b = 200.00
  d = 367.00
  d' = 33.00
  v = 0.81862252
    N = 1.8026E+006
  fc = 30.00
  co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00925707
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00925707
      we (5.4c) = 0.0207149
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.33836562
        ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
        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,max1 = 89600.00 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 external perimeter hoops.
        Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
                is calculated by reducing all the dimensions of the area Aconf,max1 by a length

equal to half the clear spacing between external hoops.
AnoConf1 = 43733.333 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
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,max2 = 45264.00 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 internal perimeter hoops.
Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 32309.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
Lstir1 (Length of stirrups along Y) = 1040.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
Lstir2 (Length of stirrups along Y) = 768.00
Astir2 (stirrups area) = 50.26548
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
Lstir1 (Length of stirrups along X) = 1040.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
Lstir2 (Length of stirrups along X) = 768.00
Astir2 (stirrups area) = 50.26548

Asec = 120000.00
s1 = 100.00
s2 = 250.00
fywe1 = 781.25
fywe2 = 625.00
fce = 30.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.0025
sh1 = 0.008
ft1 = 886.7403
fy1 = 738.9503
su1 = 0.032
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 = 1.00
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, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 738.9503
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 898.293
fy2 = 748.5775
su2 = 0.032
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 = 1.00

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 εy2, εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, 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, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 748.5775
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 894.3662
fyv = 745.3052
εsuv = 0.032
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 = 1.00
εsuv = 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, εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/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, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.38164216
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.7508007
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.67946571
and confined core properties:
b = 160.00
d = 347.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
εcc (5A.5, TBDY) = 0.002
αc = confinement factor = 1.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.50454853
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.99259314
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.898285
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
' satisfies Eq. (4.4)
--->
v < εs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
φu (4.10) = 0.52172715
MRc (4.17) = 6.3768E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
 - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
 - N, ω1, ω2, ωv normalised to bo*do, instead of b*d
 - ε - parameters of confined concrete, fcc, εcc, used in lieu of fc, εcu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied

--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 *cu (4.11) = 0.5604845
MRo (4.18) = 4.7738E+008
MRo < 0.8*MRc
--->
  u =   cu (unconfined full section) = 4.8346386E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 4.2207094E-005
Mu = 7.3334E+008
----
with full section properties:
  b = 400.00
  d = 367.00
  d' = 33.00
  v = 0.40931126
    N = 1.8026E+006
  fc = 30.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00925707
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: cu = 0.00925707
       we (5.4c) = 0.0207149
        ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.33836562
          ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
          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,max1 = 89600.00 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 external perimeter hoops.
          Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
                is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                equal to half the clear spacing between external hoops.
          AnoConf1 = 43733.333 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
        ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
          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,max2 = 45264.00 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 internal perimeter hoops.
          Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
                is calculated by reducing all the dimensions of the area Aconf,max2 by a length
                equal to half the clear spacing between internal hoops.

AnoConf2 = 32309.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
   Lstir1 (Length of stirrups along Y) = 1040.00
   Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
   Lstir2 (Length of stirrups along Y) = 768.00
   Astir2 (stirrups area) = 50.26548

----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
   Lstir1 (Length of stirrups along X) = 1040.00
   Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
   Lstir2 (Length of stirrups along X) = 768.00
   Astir2 (stirrups area) = 50.26548

Asec = 120000.00
 s1 = 100.00
 s2 = 250.00
fywe1 = 781.25
fywe2 = 625.00
fce = 30.00
From ((5.A5), TBDY), TBDY: cc = 0.002
   c = confinement factor = 1.00
y1 = 0.0025
sh1 = 0.008
ft1 = 898.293
fy1 = 748.5775
su1 = 0.032
  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 = 1.00
   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, ASCE 41-17.
    with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 748.5775
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 886.7403
fy2 = 738.9503
su2 = 0.032
  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 = 1.00
   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, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 738.9503
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 894.3662
fyv = 745.3052
suv = 0.032
  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 = 1.00
 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, ASCE 41-17.
 with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
 with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.37540035
2 = Asl,com/(b*d)*(fs2/fc) = 0.19082108
v = Asl,mid/(b*d)*(fsv/fc) = 0.33973286
and confined core properties:
 b = 360.00
 d = 347.00
 d' = 13.00
 fcc (5A.2, TBDY) = 30.00
  cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.44115251
 2 = Asl,com/(b*d)*(fs2/fc) = 0.22424379
 v = Asl,mid/(b*d)*(fsv/fc) = 0.39923778
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
 ' satisfies Eq. (4.4)
--->
v < s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
 cu (4.10) = 0.59761571
MRc (4.17) = 7.3334E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
 - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
 - N, 1, 2, v normalised to bo*do, instead of b*d
 - - parameters of confined concrete, fcc, cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 *cu (4.11) = 0.62879536
MRo (4.18) = 4.5866E+008
MRo < 0.8*MRc
--->

u = cu (unconfined full section) = 4.2207094E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 4.8346386E-005
Mu = 6.3768E+008
----
with full section properties:
  b = 200.00
  d = 367.00
  d' = 33.00
  v = 0.81862252
    N = 1.8026E+006
  fc = 30.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00925707
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00925707
      we (5.4c) = 0.0207149
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.33836562
        ase1 = Max((($A_{conf,max1}$-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
        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,max1 = 89600.00 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 external perimeter hoops.
        Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
              is calculated by reducing all the dimensions of the area Aconf,max1 by a length
              equal to half the clear spacing between external hoops.
        AnoConf1 = 43733.333 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
      ase2 (>=ase1) = Max((($A_{conf,max2}$-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
        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,max2 = 45264.00 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 internal perimeter hoops.
        Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
              is calculated by reducing all the dimensions of the area Aconf,max2 by a length
              equal to half the clear spacing between internal hoops.
        AnoConf2 = 32309.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
      psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
    Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

        ----
        psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
          Lstir1 (Length of stirrups along Y) = 1040.00
          Astir1 (stirrups area) = 78.53982
        psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
          Lstir2 (Length of stirrups along Y) = 768.00
          Astir2 (stirrups area) = 50.26548

```
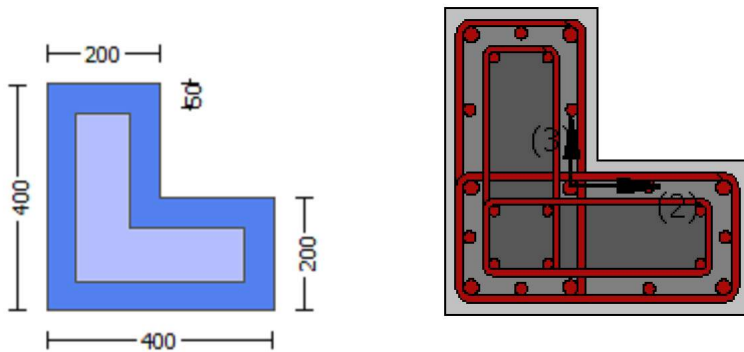      psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
      psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
         Lstir1 (Length of stirrups along X) = 1040.00
         Astir1 (stirrups area) = 78.53982
      psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
         Lstir2 (Length of stirrups along X) = 768.00
         Astir2 (stirrups area) = 50.26548
   --------------------------------------------------------------------
         Asec = 120000.00
         s1 = 100.00
         s2 = 250.00
         fywe1 = 781.25
         fywe2 = 625.00
         fce  = 30.00
    From ((5.A5), TBDY), TBDY:  cc = 0.002
         c = confinement factor = 1.00
  y1 = 0.0025
  sh1 = 0.008
 ft1 = 886.7403
 fy1 = 738.9503
  su1 = 0.032
    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 = 1.00
     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, ASCE 41-17.
     with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 738.9503
     with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.0025
  sh2 = 0.008
 ft2 = 898.293
 fy2 = 748.5775
  su2 = 0.032
    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 = 1.00
     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, ASCE 41-17.
     with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 748.5775
     with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.0025
  shv = 0.008
 ftv = 894.3662
 fyv = 745.3052
  suv = 0.032
    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 = 1.00
     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, ASCE 41-17.
     with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
     with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.38164216
  2 = Asl,com/(b*d)*(fs2/fc) = 0.7508007
```

$v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.67946571$

and confined core properties:

b = 160.00
d = 347.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
 cc (5A.5, TBDY) = 0.002
  c = confinement factor = 1.00
 1 = $A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c)$ = 0.50454853
 2 = $A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c)$ = 0.99259314
 v = $A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c)$ = 0.898285

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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
 ' satisfies Eq. (4.4)
--->
v < s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
 cu (4.10) = 0.52172715
MRc (4.17) = 6.3768E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N, 1, 2, v normalised to bo*do, instead of b*d
  - - parameters of confined concrete, fcc, cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 *cu (4.11) = 0.5604845
MRo (4.18) = 4.7738E+008
MRo < 0.8*MRc
--->
 u = cu (unconfined full section) = 4.8346386E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 339150.739

Calculation of Shear Strength at edge 1, Vr1 = 339150.739
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 339150.739
  knl = 1 (zero step-static loading)

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

    = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
    Mu = 2.0345E+006
    Vu = 2.3476251E-006
  d = 0.8*h = 320.00
  Nu = 1.8026E+006
  Ag = 80000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 471238.898
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 471238.898
  Vs,j1 = 314159.265 is calculated for section web jacket, with:
    d = 320.00
    Av = 157079.633
    fy = 625.00
    s = 100.00
  Vs,j1 is multiplied by   Col,j1 = 1.00
    s/d = 0.3125
  Vs,j2 = 157079.633 is calculated for section flange jacket, with:
    d = 160.00
    Av = 157079.633
    fy = 625.00
    s = 100.00
  Vs,j2 is multiplied by   Col,j2 = 1.00
    s/d = 0.625
  Vs,core = Vs,c1 + Vs,c2 = 0.00
  Vs,c1 = 0.00 is calculated for section web core, with:
    d = 240.00
    Av = 100530.965
    fy = 500.00
    s = 250.00
  Vs,c1 is multiplied by   Col,c1 = 0.00
    s/d = 1.04167
  Vs,c2 = 0.00 is calculated for section flange core, with:
    d = 80.00
    Av = 100530.965
    fy = 500.00
    s = 250.00
  Vs,c2 is multiplied by   Col,c2 = 0.00
    s/d = 3.125
  Vf ((11-3)-(11.4), ACI 440) = 0.00
  From (11-11), ACI 440: Vs + Vf <= 212577.225
    bw = 200.00

Calculation of Shear Strength at edge 2, Vr2 = 339150.739
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 339150.739
  knl = 1 (zero step-static loading)

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

    = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
    Mu = 6739.685

Vu = 2.3476251E-006
d = 0.8*h = 320.00
Nu = 1.8026E+006
Ag = 80000.00
From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 471238.898
where:
Vs,jacket = Vs,j1 + Vs,j2 = 471238.898
Vs,j1 = 314159.265 is calculated for section web jacket, with:
  d = 320.00
  Av = 157079.633
  fy = 625.00
  s = 100.00
Vs,j1 is multiplied by   Col,j1 = 1.00
  s/d = 0.3125
Vs,j2 = 157079.633 is calculated for section flange jacket, with:
  d = 160.00
  Av = 157079.633
  fy = 625.00
  s = 100.00
Vs,j2 is multiplied by   Col,j2 = 1.00
  s/d = 0.625
Vs,core = Vs,c1 + Vs,c2 = 0.00
Vs,c1 = 0.00 is calculated for section web core, with:
  d = 240.00
  Av = 100530.965
  fy = 500.00
  s = 250.00
Vs,c1 is multiplied by   Col,c1 = 0.00
  s/d = 1.04167
Vs,c2 = 0.00 is calculated for section flange core, with:
  d = 80.00
  Av = 100530.965
  fy = 500.00
  s = 250.00
Vs,c2 is multiplied by   Col,c2 = 0.00
  s/d = 3.125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 212577.225
  bw = 200.00

End Of Calculation of Shear Capacity ratio for element: column JLC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column JLC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjlcs

Constant Properties

Knowledge Factor,   = 0.90
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 30.00
New material of Secondary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 18.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 500.00
Concrete Elasticity, Ec = 19940.411
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
Jacket
New material: Steel Strength, fs = 1.25*fsm = 781.25
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 625.00
#########################################################
Max Height, Hmax = 400.00
Min Height, Hmin = 200.00
Max Width, Wmax = 400.00
Min Width, Wmin = 200.00
Jacket Thickness, tj = 50.00
Cover Thickness, c = 15.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping
-------------------------------------------------------------

Stepwise Properties
-------------------------------------------------------------
At local axis: 2
EDGE -A-
Shear Force, Va = -3.6347847E-006
EDGE -B-
Shear Force, Vb = 3.6347847E-006
BOTH EDGES
Axial Force, F = -1.8026E+006
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
    -Compression: Aslc = 5353.274
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 1137.257
    -Compression: Asl,com = 2208.54
       -Middle: Asl,mid = 2007.478
-------------------------------------------------------------
-------------------------------------------------------------


Calculation of Shear Capacity ratio , Ve/Vr = 1.18753
Member Controlled by Shear (Ve/Vr > 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 402750.026
with
Mpr1 = Max(Mu1+ , Mu1-) = 6.0413E+008
   Mu1+ = 6.0413E+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- = 5.4612E+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-) = 6.0413E+008
   Mu2+ = 6.0413E+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- = 5.4612E+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 = 1.2613948E-005
```

Mu = 6.0413E+008

----

with full section properties:
   b = 400.00
   d = 367.00
   d' = 33.00
   v = 0.40931126
      N = 1.8026E+006
   fc = 30.00
     co (5A.5, TBDY) = 0.002
   Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00925707
      The Shear_factor is considered equal to 1 (pure moment strength)
      From (5.4b), TBDY: cu = 0.00925707
         we (5.4c) = 0.0207149
         ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.33836562
            ase1 = Max((((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
            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,max1 = 89600.00 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 external perimeter hoops.
            Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
                  is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                  equal to half the clear spacing between external hoops.
            AnoConf1 = 43733.333 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
         ase2 (>=ase1) = Max((((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
            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,max2 = 45264.00 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 internal perimeter hoops.
            Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
                  is calculated by reducing all the dimensions of the area Aconf,max2 by a length
                  equal to half the clear spacing between internal hoops.
            AnoConf2 = 32309.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
         psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
      Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
         ----
         psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
         psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
            Lstir1 (Length of stirrups along Y) = 1040.00
            Astir1 (stirrups area) = 78.53982
         psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
            Lstir2 (Length of stirrups along Y) = 768.00
            Astir2 (stirrups area) = 50.26548
         ----
         psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
         psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
            Lstir1 (Length of stirrups along X) = 1040.00
            Astir1 (stirrups area) = 78.53982
         psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
            Lstir2 (Length of stirrups along X) = 768.00
            Astir2 (stirrups area) = 50.26548

            Asec = 120000.00
            s1 = 100.00
            s2 = 250.00
         fywe1 = 781.25
         fywe2 = 625.00
         fce = 30.00
      From ((5.A5), TBDY), TBDY: cc = 0.002
         c = confinement factor = 1.00

```
    y1 = 0.0025
    sh1 = 0.008
  ft1 = 886.7403
  fy1 = 738.9503
    su1 = 0.032
      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 = 1.00
        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, ASCE 41-17.
        with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 738.9503
        with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
    y2 = 0.0025
    sh2 = 0.008
  ft2 = 898.293
  fy2 = 748.5775
    su2 = 0.032
      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 = 1.00
        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, ASCE 41-17.
        with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 748.5775
        with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
    yv = 0.0025
    shv = 0.008
  ftv = 894.3662
  fyv = 745.3052
    suv = 0.032
      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 = 1.00
        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, ASCE 41-17.
        with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
        with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.19082108
    2 = Asl,com/(b*d)*(fs2/fc) = 0.37540035
    v = Asl,mid/(b*d)*(fsv/fc) = 0.33973286
and confined core properties:
  b = 360.00
  d = 347.00
  d' = 13.00
  fcc (5A.2, TBDY) = 30.00
    cc (5A.5, TBDY) = 0.002
        c  = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.22424379
    2 = Asl,com/(b*d)*(fs2/fc) = 0.44115251
    v = Asl,mid/(b*d)*(fsv/fc) = 0.39923778
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
  ' satisfies Eq. (4.4)
--->
v < s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
 cu (4.10) = 0.37716748
MRc (4.17) = 7.0585E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N, 1, 2, v normalised to bo*do, instead of b*d
  - - parameters of confined concrete, fcc, cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 *cu (4.11) = 0.4569298
MRo (4.18) = 6.0413E+008
--->
  u =   cu (4.2) = 1.2613948E-005
Mu = MRo

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 3.1475172E-005
Mu = 5.4612E+008
----
with full section properties:
  b = 200.00
  d = 367.00
  d' = 33.00
  v = 0.81862252
    N = 1.8026E+006
  fc = 30.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00925707
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00925707
      we (5.4c) = 0.0207149

ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.33836562

    ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562

    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,max1 = 89600.00 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 external perimeter hoops.
    Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
        is calculated by reducing all the dimensions of the area Aconf,max1 by a length
        equal to half the clear spacing between external hoops.
    AnoConf1 = 43733.333 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).

    ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562

    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,max2 = 45264.00 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 internal perimeter hoops.
    Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
        is calculated by reducing all the dimensions of the area Aconf,max2 by a length
        equal to half the clear spacing between internal hoops.
    AnoConf2 = 32309.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).

psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205

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

----

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
    Lstir1 (Length of stirrups along Y) = 1040.00
    Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
    Lstir2 (Length of stirrups along Y) = 768.00
    Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
    Lstir1 (Length of stirrups along X) = 1040.00
    Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
    Lstir2 (Length of stirrups along X) = 768.00
    Astir2 (stirrups area) = 50.26548

    Asec = 120000.00
    s1 = 100.00
    s2 = 250.00
  fywe1 = 781.25
  fywe2 = 625.00
  fce = 30.00
From ((5.A5), TBDY: cc = 0.002
  c = confinement factor = 1.00
y1 = 0.0025
sh1 = 0.008
ft1 = 898.293
fy1 = 748.5775
su1 = 0.032
  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 = 1.00
  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, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 748.5775
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 886.7403
fy2 = 738.9503
su2 = 0.032
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 = 1.00
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, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 738.9503
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 894.3662
fyv = 745.3052
suv = 0.032
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 = 1.00
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, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.7508007
2 = Asl,com/(b*d)*(fs2/fc) = 0.38164216
v = Asl,mid/(b*d)*(fsv/fc) = 0.67946571
and confined core properties:
b = 160.00
d = 347.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.99259314
2 = Asl,com/(b*d)*(fs2/fc) = 0.50454853
v = Asl,mid/(b*d)*(fsv/fc) = 0.898285
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
' satisfies Eq. (4.4)
--->
v <   s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is not satisfied
--->
cu (4.11) = 0.80138156
MRc (4.18) = 5.4612E+008
--->

New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N, φ1, φ2, v normalised to bo*do, instead of b*d
  - - parameters of confined concrete, fcc, εcc, used in lieu of fc, εcu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.80674817
MRo (4.18) = 2.8580E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 3.1475172E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 1.2613948E-005
Mu = 6.0413E+008
----
with full section properties:
  b = 400.00
  d = 367.00
  d' = 33.00
  v = 0.40931126
    N = 1.8026E+006
  fc = 30.00
  εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.00925707
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.00925707
      ωwe (5.4c) = 0.0207149
      αse ((5.4d), TBDY) = (αse1*Aext+αse2*Aint)/Asec = 0.33836562
        αse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
        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,max1 = 89600.00 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 external perimeter hoops.
        Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
            is calculated by reducing all the dimensions of the area Aconf,max1 by a length
            equal to half the clear spacing between external hoops.
        AnoConf1 = 43733.333 is the unconfined external core area which is equal to Σbi2/6 as defined at (A.2).

ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
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,max2 = 45264.00 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 internal perimeter hoops.
Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 32309.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
Lstir1 (Length of stirrups along Y) = 1040.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
Lstir2 (Length of stirrups along Y) = 768.00
Astir2 (stirrups area) = 50.26548

----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
Lstir1 (Length of stirrups along X) = 1040.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
Lstir2 (Length of stirrups along X) = 768.00
Astir2 (stirrups area) = 50.26548

Asec = 120000.00
s1 = 100.00
s2 = 250.00
fywe1 = 781.25
fywe2 = 625.00
fce = 30.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.0025
sh1 = 0.008
ft1 = 886.7403
fy1 = 738.9503
su1 = 0.032
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 = 1.00
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, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 738.9503
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 898.293
fy2 = 748.5775
su2 = 0.032
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 = 1.00
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 γ2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
γ1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 748.5775
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
γv = 0.0025
shv = 0.008
ftv = 894.3662
fyv = 745.3052
suv = 0.032
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 = 1.00
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 γv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
γ1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.19082108
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.37540035
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.33973286
and confined core properties:
b = 360.00
d = 347.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
εcc (5A.5, TBDY) = 0.002
αc = confinement factor = 1.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.22424379
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.44115251
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.39923778
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
' satisfies Eq. (4.4)
--->
v < εs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
φcu (4.10) = 0.37716748
MRc (4.17) = 7.0585E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ω1, ω2, ωv normalised to bo*do, instead of b*d
- ε - parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected

--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 *cu (4.11) = 0.4569298
MRo (4.18) = 6.0413E+008
--->
  u =   cu (4.2) = 1.2613948E-005
Mu = MRo

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 3.1475172E-005
Mu = 5.4612E+008
----
with full section properties:
  b = 200.00
  d = 367.00
  d' = 33.00
  v = 0.81862252
    N = 1.8026E+006
  fc = 30.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00925707
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00925707
      we (5.4c) = 0.0207149
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.33836562
        ase1 = Max((((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
        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,max1 = 89600.00 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 external perimeter hoops.
        Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
              is calculated by reducing all the dimensions of the area Aconf,max1 by a length
              equal to half the clear spacing between external hoops.
        AnoConf1 = 43733.333 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
      ase2 (>=ase1) = Max((((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
        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,max2 = 45264.00 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 internal perimeter hoops.
        Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
              is calculated by reducing all the dimensions of the area Aconf,max2 by a length
              equal to half the clear spacing between internal hoops.
        AnoConf2 = 32309.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
      psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
    Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without

earthquake detailing (90° closed stirrups)

$psh\_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205$

$psh1\ ((5.4d),\ TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678$

Lstir1 (Length of stirrups along Y) = 1040.00

Astir1 (stirrups area) = 78.53982

$psh2\ (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868$

Lstir2 (Length of stirrups along Y) = 768.00

Astir2 (stirrups area) = 50.26548

$psh\_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205$

$psh1\ ((5.4d),\ TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678$

Lstir1 (Length of stirrups along X) = 1040.00

Astir1 (stirrups area) = 78.53982

$psh2\ ((5.4d),\ TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868$

Lstir2 (Length of stirrups along X) = 768.00

Astir2 (stirrups area) = 50.26548

Asec = 120000.00

s1 = 100.00

s2 = 250.00

fywe1 = 781.25

fywe2 = 625.00

fce = 30.00

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

c = confinement factor = 1.00

y1 = 0.0025

sh1 = 0.008

ft1 = 898.293

fy1 = 748.5775

su1 = 0.032

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 = 1.00

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

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, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 748.5775

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.0025

sh2 = 0.008

ft2 = 886.7403

fy2 = 738.9503

su2 = 0.032

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 = 1.00

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

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, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 738.9503

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.0025

shv = 0.008

ftv = 894.3662

fyv = 745.3052

suv = 0.032

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 = 1.00

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, ASCE 41-17.
  with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
 ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.7508007
 ω2 = Asl,com/(b*d)*(fs2/fc) = 0.38164216
 ωv = Asl,mid/(b*d)*(fsv/fc) = 0.67946571
and confined core properties:
  b = 160.00
  d = 347.00
  d' = 13.00
 fcc (5A.2, TBDY) = 30.00
  ϵcc (5A.5, TBDY) = 0.002
   λc = confinement factor = 1.00
 ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.99259314
 ω2 = Asl,com/(b*d)*(fs2/fc) = 0.50454853
 ωv = Asl,mid/(b*d)*(fsv/fc) = 0.898285
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
 ' satisfies Eq. (4.4)
--->
v < ωs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is not satisfied
--->
 ξcu (4.11) = 0.80138156
MRc (4.18) = 5.4612E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N, ω1, ω2, ωv normalised to bo*do, instead of b*d
  - λ - parameters of confined concrete, fcc, ϵcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 ξ*cu (4.11) = 0.80674817
MRo (4.18) = 2.8580E+008
MRo < 0.8*MRc
--->
 ϕu = ξcu (unconfined full section) = 3.1475172E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 339150.739

Calculation of Shear Strength at edge 1, Vr1 = 339150.739
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
   VCol0 = 339150.739
   knl = 1 (zero step-static loading)

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

    = 1 (normal-weight concrete)
   Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
   M/Vd = 4.00
      Mu = 6.7415E+007
      Vu = 3.6347847E-006
   d = 0.8*h = 320.00
   Nu = 1.8026E+006
   Ag = 80000.00
   From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 471238.898
   where:
  Vs,jacket = Vs,j1 + Vs,j2 = 471238.898
  Vs,j1 = 157079.633 is calculated for section web jacket, with:
     d = 160.00
     Av = 157079.633
     fy = 625.00
     s = 100.00
  Vs,j1 is multiplied by Col,j1 = 1.00
     s/d = 0.625
  Vs,j2 = 314159.265 is calculated for section flange jacket, with:
     d = 320.00
     Av = 157079.633
     fy = 625.00
     s = 100.00
  Vs,j2 is multiplied by Col,j2 = 1.00
     s/d = 0.3125
  Vs,core = Vs,c1 + Vs,c2 = 0.00
  Vs,c1 = 0.00 is calculated for section web core, with:
     d = 80.00
     Av = 100530.965
     fy = 500.00
     s = 250.00
  Vs,c1 is multiplied by Col,c1 = 0.00
     s/d = 3.125
  Vs,c2 = 0.00 is calculated for section flange core, with:
     d = 240.00
     Av = 100530.965
     fy = 500.00
     s = 250.00
  Vs,c2 is multiplied by Col,c2 = 0.00
     s/d = 1.04167
  Vf ((11-3)-(11.4), ACI 440) = 0.00
   From (11-11), ACI 440: Vs + Vf <= 212577.225
     bw = 200.00

Calculation of Shear Strength at edge 2, Vr2 = 339150.739
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
   VCol0 = 339150.739

knl = 1 (zero step-static loading)

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

= 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
M/Vd = 4.00
  Mu = 5.3429E+007
  Vu = 3.6347847E-006
d = 0.8*h = 320.00
Nu = 1.8026E+006
Ag = 80000.00
From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 471238.898
where:
Vs,jacket = Vs,j1 + Vs,j2 = 471238.898
Vs,j1 = 157079.633 is calculated for section web jacket, with:
  d = 160.00
  Av = 157079.633
  fy = 625.00
  s = 100.00
Vs,j1 is multiplied by Col,j1 = 1.00
  s/d = 0.625
Vs,j2 = 314159.265 is calculated for section flange jacket, with:
  d = 320.00
  Av = 157079.633
  fy = 625.00
  s = 100.00
Vs,j2 is multiplied by Col,j2 = 1.00
  s/d = 0.3125
Vs,core = Vs,c1 + Vs,c2 = 0.00
Vs,c1 = 0.00 is calculated for section web core, with:
  d = 80.00
  Av = 100530.965
  fy = 500.00
  s = 250.00
Vs,c1 is multiplied by Col,c1 = 0.00
  s/d = 3.125
Vs,c2 = 0.00 is calculated for section flange core, with:
  d = 240.00
  Av = 100530.965
  fy = 500.00
  s = 250.00
Vs,c2 is multiplied by Col,c2 = 0.00
  s/d = 1.04167
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 212577.225
  bw = 200.00

End Of Calculation of Shear Capacity ratio for element: column JLC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column JLC1 of floor 1
At local axis: 3
Integration Section: (a)
Section Type: rcjlcs

Constant Properties

Knowledge Factor, = 0.90
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 30.00
New material of Secondary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 18.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 500.00
Concrete Elasticity, Ec = 19940.411
Steel Elasticity, Es = 200000.00
Max Height, Hmax = 400.00
Min Height, Hmin = 200.00
Max Width, Wmax = 400.00
Min Width, Wmin = 200.00
Jacket Thickness, tj = 50.00
Cover Thickness, c = 15.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lb/ld>=1)
No FRP Wrapping

Stepwise Properties

Bending Moment, M = -3.4056E+008
Shear Force, V2 = -97644.268
Shear Force, V3 = -30.34672
Axial Force, F = -1.8003E+006
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 2161.416
     -Compression: Aslc = 3191.858
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 2208.54
     -Compression: Asl,com = 1137.257
         -Middle: Asl,mid = 2007.478
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,jacket = 1746.726
     -Compression: Asl,com,jacket = 829.3805
         -Middle: Asl,mid,jacket = 1545.664
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,core = 461.8141
     -Compression: Asl,com,core = 307.8761
         -Middle: Asl,mid,core = 461.8141
Mean Diameter of Tension Reinforcement, DbL = 16.60

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = * θu = 0.01311129
 θu = θy + θp = 0.0145681

 - Calculation of θy -

 θy = (My*Ls/3)/Eleff = 0.0145681 ((4.29),Biskinis Phd))
  My = 3.1266E+008
  Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3487.751
  From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 2.4951E+013
     factor = 0.70
        Ag = 120000.00
        Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00
        N = 1.8003E+006

Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.5645E+013

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7 -
----
 y = Min(y_ten, y_com)
 y_ten = 1.9271316E-005
 with fy = 596.2441
    d = 367.00
     y = 0.57848146
    A = 0.11407012
    B = 0.08752406
     with pt = 0.0300891
         pc = 0.01549396
         pv = 0.02734983
         N = 1.8003E+006
         b = 200.00
         " = 0.08991826
 y_comp = 7.6825402E-006
 with fc = 30.00
    Ec = 25742.96
     y = 0.74398532
    A = 0.01446815
    B = 0.04638683
     with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

 - 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/VColOE = 1.18753
  d = d_external = 367.00
  s = s_external = 100.00
 - t = s1 + s2 + 2*tf/bw*(ffe/fs) = 0.00809358
  jacket: s1 = Av1*Lstir1/(s1*Ag) = 0.00680678
      Av1 = 78.53982, is the area of every stirrup parallel to loading (shear) direction
      Lstir1 = 1040.00, is the total Length of all stirrups parallel to loading (shear) direction
      s1 = 100.00
  core: s2 = Av2*Lstir2/(s2*Ag) = 0.0012868
      Av2 = 50.26548, is the area of every stirrup parallel to loading (shear) direction
      Lstir2 = 768.00, is the total Length of all stirrups parallel to loading (shear) direction
      s2 = 250.00
  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.
  For the normalisation fs of jacket is used.
   NUD = 1.8003E+006
   Ag = 120000.00
   f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 25.00
   fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein = 596.2441
   fytE = (fy_ext_Trans_Reinf* s1+fy_int_Trans_Reinf* s2)/(s1+ s2) = 605.1263
pl = Area_Tot_Long_Rein/(b*d) = 0.07293289
  b = 200.00
  d = 367.00
   f'cE = 25.00

End Of Calculation of Chord Rotation Capacity for element: column JLC1 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 50 and 51)

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (2)

Start Of Calculation of Shear Capacity for element: column JLC1 of floor 1
At local axis: 2
Integration Section: (b)
Section Type: rcjlcs

Constant Properties

Knowledge Factor,   = 0.90
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 12.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 19940.411
Steel Elasticity, Es = 200000.00

```
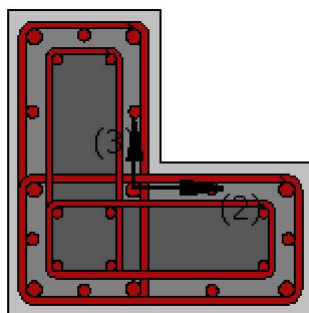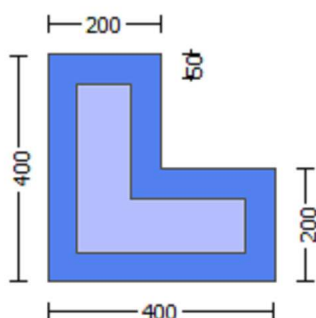############################################################
Note: Especially for the calculation of  y for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 30.00
New material: Steel Strength, fs = fsm = 625.00
Existing Column
Existing material: Concrete Strength, fc = fcm = 18.00
Existing material: Steel Strength, fs = fsm = 500.00
############################################################
Max Height, Hmax = 400.00
Min Height, Hmin = 200.00
Max Width, Wmax = 400.00
Min Width, Wmin = 200.00
Jacket Thickness, tj = 50.00
Cover Thickness, c = 15.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min = lb/ld >=1)
No FRP Wrapping
-------------------------------------------------------------

Stepwise Properties
-------------------------------------------------------------
EDGE -A-
Bending Moment, Ma = -3.4056E+008
Shear Force, Va = -97644.268
EDGE -B-
Bending Moment, Mb = -7.2803E+007
Shear Force, Vb = 97644.268
BOTH EDGES
Axial Force, F = -1.8003E+006
Longitudinal Reinforcement Area Distribution (in 2 divisions)
       -Tension: Aslt = 0.00
     -Compression: Aslc = 5353.274
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1137.257
      -Compression: Asl,com = 2208.54
        -Middle: Asl,mid = 2007.478
Mean Diameter of Tension Reinforcement, DbL,ten = 16.80
-------------------------------------------------------------
-------------------------------------------------------------


Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR =   *Vn = 331196.688
Vn ((10.3), ASCE 41-17) = knl*VColO = 367996.32
   VCol = 367996.32
   knl = 1.00
      displacement_ductility_demand = 0.53336237
-------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+  f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
-------------------------------------------------------------
    = 1 (normal-weight concrete)
   Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 16.66667, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
   M/Vd = 2.33
      Mu = 7.2803E+007
      Vu = 97644.268
   d = 0.8*h = 320.00
   Nu = 1.8003E+006
   Ag = 80000.00
```

From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 376991.118
    where:
   Vs,jacket = Vs,j1 + Vs,j2 = 376991.118
   Vs,j1 = 125663.706 is calculated for section web jacket, with:
      d = 160.00
      Av = 157079.633
      fy = 500.00
      s = 100.00
   Vs,j1 is multiplied by   Col,j1 = 1.00
      s/d = 0.625
   Vs,j2 = 251327.412 is calculated for section flange jacket, with:
      d = 320.00
      Av = 157079.633
      fy = 500.00
      s = 100.00
   Vs,j2 is multiplied by   Col,j2 = 1.00
      s/d = 0.3125
   Vs,core = Vs,c1 + Vs,c2 = 0.00
   Vs,c1 = 0.00 is calculated for section web core, with:
      d = 80.00
      Av = 100530.965
      fy = 400.00
      s = 250.00
   Vs,c1 is multiplied by   Col,c1 = 0.00
      s/d = 3.125
   Vs,c2 = 0.00 is calculated for section flange core, with:
      d = 240.00
      Av = 100530.965
      fy = 400.00
      s = 250.00
   Vs,c2 is multiplied by   Col,c2 = 0.00
      s/d = 1.04167
   Vf ((11-3)-(11.4), ACI 440) = 0.00
   From (11-11), ACI 440: Vs + Vf <= 173568.578
      bw = 200.00

----
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   = 0.00279899
  y = (My*Ls/3)/Eleff = 0.00524781 ((4.29),Biskinis Phd))
   My = 5.2685E+008
   Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 745.5987
   From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 2.4951E+013
      factor = 0.70
        Ag = 120000.00
        Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00
        N = 1.8003E+006
      Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.5645E+013

Calculation of Yielding Moment My

Calculation of   y and My according to Annex 7   -

Assuming neutral axis within flange (y < t/d, compression zone rectangular) with:
flange width, b = 400.00
web width, bw = 200.00
flange thickness, t = 200.00
----
  y = Min(y_ten, y_com)
  y_ten = 1.4407218E-005

```
with fy = 596.2441
    d = 367.00
    y = 0.43617034
    A = 0.05703506
    B = 0.03712065
    with pt = 0.00774698
       pc = 0.01504455
       pv = 0.01367492
       N = 1.8003E+006
       b = 400.00
       " = 0.08991826
  y_comp = 1.2588515E-005
with fc = 30.00
    Ec = 25742.96
    y = 0.45404063
    A = 0.00723408
    B = 0.01655203
    with Es = 200000.00
CONFIRMATION:  y = 0.45404063 < t/d
---------------------------------------------------------

Calculation of ratio lb/ld
---------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
---------------------------------------------------------
End Of Calculation of Shear Capacity for element: column JLC1 of floor 1
At local axis: 2
Integration Section: (b)


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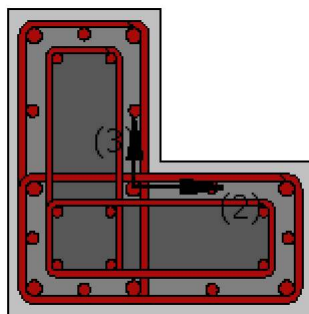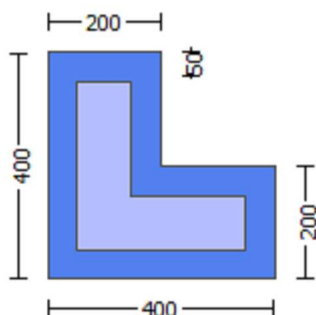```

# Calculation No. 6

column C1, Floor 1

Limit State: Operational Level (data interpolation between analysis steps 50 and 51)

Analysis: Uniform +X

Check: Chord rotation capacity ( u)

Edge: End

Local Axis: (2)

Start Of Calculation of Shear Capacity ratio for element: column JLC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcjlcs

Constant Properties
------------------------------------------------------------
Knowledge Factor,   = 0.90
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 30.00
New material of Secondary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 18.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 500.00
Concrete Elasticity, Ec = 19940.411
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
Jacket
New material: Steel Strength, fs = 1.25*fsm = 781.25
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 625.00
############################################################
Max Height, Hmax = 400.00
Min Height, Hmin = 200.00
Max Width, Wmax = 400.00
Min Width, Wmin = 200.00
Jacket Thickness, tj = 50.00
Cover Thickness, c = 15.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping
------------------------------------------------------------

Stepwise Properties
------------------------------------------------------------
At local axis: 3
EDGE -A-
Shear Force, Va = 2.3476251E-006
EDGE -B-
Shear Force, Vb = -2.3476251E-006
BOTH EDGES
Axial Force, F = -1.8026E+006
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
      -Compression: Aslc = 5353.274
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 2208.54
     -Compression: Asl,com = 1137.257
       -Middle: Asl,mid = 2007.478
--------------------------------------------------------------
--------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr  =  1.44151
Member Controlled by Shear (Ve/Vr > 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 488890.189
with
Mpr1 =  Max(Mu1+ , Mu1-) = 7.3334E+008
  Mu1+ = 7.3334E+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- = 6.3768E+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-) = 7.3334E+008
  Mu2+ = 7.3334E+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- = 6.3768E+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 = 4.2207094E-005
Mu = 7.3334E+008
------------------------------------------------------------------------
with full section properties:
  b = 400.00
  d = 367.00
  d' = 33.00
  v = 0.40931126
    N = 1.8026E+006
  fc = 30.00
   co (5A.5, TBDY) = 0.002
  Final value of  cu:  cu* = shear_factor * Max( cu, cc) = 0.00925707
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY:  cu = 0.00925707
      we (5.4c) = 0.0207149
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.33836562
        ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
        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,max1 = 89600.00 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 external perimeter hoops.
        Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
                is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                equal to half the clear spacing between external hoops.
        AnoConf1 = 43733.333 is the unconfined external core area which is equal to  bi2/6 as defined at (A.2).
      ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
        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,max2 = 45264.00 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 internal perimeter hoops.
        Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
                is calculated by reducing all the dimensions of the area Aconf,max2 by a length
                equal to half the clear spacing between internal hoops.
        AnoConf2 = 32309.333 is the unconfined internal core area which is equal to  bi2/6 as defined at (A.2).
      psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
    Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
        ----------------------------------------------------------
        psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678

```
              Lstir1 (Length of stirrups along Y) = 1040.00
              Astir1 (stirrups area) = 78.53982
         psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
              Lstir2 (Length of stirrups along Y) = 768.00
              Astir2 (stirrups area) = 50.26548
    ------------------------------------------------------------------
         psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
         psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
              Lstir1 (Length of stirrups along X) = 1040.00
              Astir1 (stirrups area) = 78.53982
         psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
              Lstir2 (Length of stirrups along X) = 768.00
              Astir2 (stirrups area) = 50.26548
    ------------------------------------------------------------------
              Asec = 120000.00
              s1 = 100.00
              s2 = 250.00
           fywe1 = 781.25
           fywe2 = 625.00
           fce = 30.00
      From ((5.A5), TBDY), TBDY:  cc = 0.002
           c = confinement factor = 1.00
   y1 = 0.0025
  sh1 = 0.008
 ft1 = 898.293
 fy1 = 748.5775
  su1 = 0.032
     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 = 1.00
      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, ASCE 41-17.
       with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 748.5775
       with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
   y2 = 0.0025
  sh2 = 0.008
 ft2 = 886.7403
 fy2 = 738.9503
  su2 = 0.032
     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 = 1.00
      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, ASCE 41-17.
       with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 738.9503
       with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
   yv = 0.0025
  shv = 0.008
 ftv = 894.3662
 fyv = 745.3052
  suv = 0.032
     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 = 1.00
      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, ASCE 41-17.
　　with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
　　with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
　1 = Asl,ten/(b*d)*(fs1/fc) = 0.37540035
　2 = Asl,com/(b*d)*(fs2/fc) = 0.19082108
　v = Asl,mid/(b*d)*(fsv/fc) = 0.33973286
and confined core properties:
　b = 360.00
　d = 347.00
　d' = 13.00
　fcc (5A.2, TBDY) = 30.00
　　cc (5A.5, TBDY) = 0.002
　　　c = confinement factor = 1.00
　1 = Asl,ten/(b*d)*(fs1/fc) = 0.44115251
　2 = Asl,com/(b*d)*(fs2/fc) = 0.22424379
　v = Asl,mid/(b*d)*(fsv/fc) = 0.39923778
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
　' satisfies Eq. (4.4)
--->
v <　s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
　cu (4.10) = 0.59761571
MRc (4.17) = 7.3334E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
　- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
　- N,　1,　2,　v normalised to bo*do, instead of b*d
　-　-　parameters of confined concrete, fcc,　cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
　*cu (4.11) = 0.62879536
MRo (4.18) = 4.5866E+008
MRo < 0.8*MRc
--->
　u =　cu (unconfined full section) =　4.2207094E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 4.8346386E-005
Mu = 6.3768E+008
----
with full section properties:
  b = 200.00
  d = 367.00
  d' = 33.00
  ν = 0.81862252
     N = 1.8026E+006
  fc = 30.00
   εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.00925707
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: εcu = 0.00925707
        ωwe (5.4c) = 0.0207149
        αse ((5.4d), TBDY) = (αse1*Aext+αse2*Aint)/Asec = 0.33836562
           αse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
           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,max1 = 89600.00 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 external perimeter hoops.
           Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
                   is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                   equal to half the clear spacing between external hoops.
           AnoConf1 = 43733.333 is the unconfined external core area which is equal to Σbi2/6 as defined at (A.2).
           αse2 (>=αse1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
           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,max2 = 45264.00 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 internal perimeter hoops.
           Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
                   is calculated by reducing all the dimensions of the area Aconf,max2 by a length
                   equal to half the clear spacing between internal hoops.
           AnoConf2 = 32309.333 is the unconfined internal core area which is equal to Σbi2/6 as defined at (A.2).
        ρsh,min*Fywe = Min(ρsh,x*Fywe , ρsh,y*Fywe) = 6.12205
     Expression (5.4d) for ρsh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

        ρsh_x*Fywe = ρsh1*Fywe1+ρs2*Fywe2 = 6.12205
        ρsh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
           Lstir1 (Length of stirrups along Y) = 1040.00
           Astir1 (stirrups area) = 78.53982
        ρsh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
           Lstir2 (Length of stirrups along Y) = 768.00
           Astir2 (stirrups area) = 50.26548

        ρsh_y*Fywe = ρsh1*Fywe1+ρs2*Fywe2 = 6.12205
        ρsh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
           Lstir1 (Length of stirrups along X) = 1040.00
           Astir1 (stirrups area) = 78.53982
        ρsh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
           Lstir2 (Length of stirrups along X) = 768.00
           Astir2 (stirrups area) = 50.26548

```
----------------------------------------------------------------------
        Asec = 120000.00
          s1 = 100.00
          s2 = 250.00
       fywe1 = 781.25
       fywe2 = 625.00
        fce  = 30.00
    From ((5.A.5), TBDY),  TBDY:  cc = 0.002
        c  = confinement factor = 1.00
   y1 = 0.0025
  sh1 = 0.008
 ft1 = 886.7403
 fy1 = 738.9503
  su1 = 0.032
    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 = 1.00
     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, ASCE 41-17.
      with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 738.9503
      with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
   y2 = 0.0025
  sh2 = 0.008
 ft2 = 898.293
 fy2 = 748.5775
  su2 = 0.032
    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 = 1.00
     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, ASCE 41-17.
      with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 748.5775
      with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
   yv = 0.0025
  shv = 0.008
 ftv = 894.3662
 fyv = 745.3052
  suv = 0.032
    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 = 1.00
     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, ASCE 41-17.
      with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
      with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.38164216
    2 = Asl,com/(b*d)*(fs2/fc) = 0.7508007
    v = Asl,mid/(b*d)*(fsv/fc) = 0.67946571
 and confined core properties:
  b = 160.00
  d = 347.00
  d' = 13.00
  fcc (5A.2, TBDY) = 30.00
   cc (5A.5, TBDY) = 0.002
```

c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.50454853
2 = Asl,com/(b*d)*(fs2/fc) = 0.99259314
v = Asl,mid/(b*d)*(fsv/fc) = 0.898285
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
' satisfies Eq. (4.4)
--->
v <   s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
cu (4.10) = 0.52172715
MRc (4.17) = 6.3768E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N, 1, 2, v normalised to bo*do, instead of b*d
  - - parameters of confined concrete, fcc, cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
*cu (4.11) = 0.5604845
MRo (4.18) = 4.7738E+008
MRo < 0.8*MRc
--->
u = cu (unconfined full section) = 4.8346386E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 4.2207094E-005
Mu = 7.3334E+008
----
with full section properties:
  b = 400.00

d = 367.00
d' = 33.00
v = 0.40931126
  N = 1.8026E+006
fc = 30.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00925707
  The Shear_factor is considered equal to 1 (pure moment strength)
  From (5.4b), TBDY: cu = 0.00925707
    we (5.4c) = 0.0207149
    ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.33836562
      ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
      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,max1 = 89600.00 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 external perimeter hoops.
      Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
          is calculated by reducing all the dimensions of the area Aconf,max1 by a length
          equal to half the clear spacing between external hoops.
      AnoConf1 = 43733.333 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
    ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
      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,max2 = 45264.00 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 internal perimeter hoops.
      Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
          is calculated by reducing all the dimensions of the area Aconf,max2 by a length
          equal to half the clear spacing between internal hoops.
      AnoConf2 = 32309.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
    psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
  Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
    ----
      psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
      psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
        Lstir1 (Length of stirrups along Y) = 1040.00
        Astir1 (stirrups area) = 78.53982
      psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
        Lstir2 (Length of stirrups along Y) = 768.00
        Astir2 (stirrups area) = 50.26548
    ----
      psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
      psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
        Lstir1 (Length of stirrups along X) = 1040.00
        Astir1 (stirrups area) = 78.53982
      psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
        Lstir2 (Length of stirrups along X) = 768.00
        Astir2 (stirrups area) = 50.26548

      Asec = 120000.00
      s1 = 100.00
      s2 = 250.00
    fywe1 = 781.25
    fywe2 = 625.00
    fce = 30.00
  From ((5.A5), TBDY), TBDY: cc = 0.002
    c = confinement factor = 1.00
  y1 = 0.0025
  sh1 = 0.008
ft1 = 898.293
fy1 = 748.5775

su1 = 0.032
  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 = 1.00
   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, ASCE 41-17.
   with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 748.5775
   with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
 y2 = 0.0025
 sh2 = 0.008
ft2 = 886.7403
fy2 = 738.9503
 su2 = 0.032
  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 = 1.00
   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, ASCE 41-17.
   with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 738.9503
   with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
 yv = 0.0025
 shv = 0.008
ftv = 894.3662
fyv = 745.3052
 suv = 0.032
  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 = 1.00
   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, ASCE 41-17.
   with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
   with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.37540035
 2 = Asl,com/(b*d)*(fs2/fc) = 0.19082108
 v = Asl,mid/(b*d)*(fsv/fc) = 0.33973286
and confined core properties:
 b = 360.00
 d = 347.00
 d' = 13.00
 fcc (5A.2, TBDY) = 30.00
  cc (5A.5, TBDY) = 0.002
   c = confinement factor = 1.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.44115251
  2 = Asl,com/(b*d)*(fs2/fc) = 0.22424379
  v = Asl,mid/(b*d)*(fsv/fc) = 0.39923778
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 not satisfied
--->
Case/Assumption Rejected.
--->

New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
  ' satisfies Eq. (4.4)
--->
v < ε s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
 cu (4.10) = 0.59761571
MRc (4.17) = 7.3334E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N, ε1, ε2, v normalised to bo*do, instead of b*d
  - - parameters of confined concrete, fcc, εcc, used in lieu of fc, εcu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 *cu (4.11) = 0.62879536
MRo (4.18) = 4.5866E+008
MRo < 0.8*MRc
--->
 u = εcu (unconfined full section) = 4.2207094E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature εu according to 4.1, Biskinis/Fardis 2013:
 u = 4.8346386E-005
Mu = 6.3768E+008
----
with full section properties:
  b = 200.00
  d = 367.00
  d' = 33.00
  v = 0.81862252
    N = 1.8026E+006
  fc = 30.00
  εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.00925707
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.00925707
      ωwe (5.4c) = 0.0207149
       αse ((5.4d), TBDY) = (αse1*Aext+αse2*Aint)/Asec = 0.33836562
        αse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
        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,max1 = 89600.00 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 external perimeter hoops.
Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max1 by a length
equal to half the clear spacing between external hoops.
AnoConf1 = 43733.333 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
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,max2 = 45264.00 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 internal perimeter hoops.
Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 32309.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
Lstir1 (Length of stirrups along Y) = 1040.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
Lstir2 (Length of stirrups along Y) = 768.00
Astir2 (stirrups area) = 50.26548
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
Lstir1 (Length of stirrups along X) = 1040.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
Lstir2 (Length of stirrups along X) = 768.00
Astir2 (stirrups area) = 50.26548

Asec = 120000.00
s1 = 100.00
s2 = 250.00
fywe1 = 781.25
fywe2 = 625.00
fce = 30.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.0025
sh1 = 0.008
ft1 = 886.7403
fy1 = 738.9503
su1 = 0.032
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 = 1.00
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, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 738.9503
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025

sh2 = 0.008
ft2 = 898.293
fy2 = 748.5775
su2 = 0.032
    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 = 1.00
      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, ASCE 41-17.
       with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 748.5775
       with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.0025
  shv = 0.008
 ftv = 894.3662
 fyv = 745.3052
  suv = 0.032
    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 = 1.00
      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, ASCE 41-17.
       with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
       with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.38164216
     2 = Asl,com/(b*d)*(fs2/fc) = 0.7508007
     v = Asl,mid/(b*d)*(fsv/fc) = 0.67946571
and confined core properties:
  b = 160.00
  d = 347.00
  d' = 13.00
  fcc (5A.2, TBDY) = 30.00
   cc (5A.5, TBDY) = 0.002
      c = confinement factor = 1.00
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.50454853
     2 = Asl,com/(b*d)*(fs2/fc) = 0.99259314
     v = Asl,mid/(b*d)*(fsv/fc) = 0.898285
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
  ' satisfies Eq. (4.4)
--->
v < s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
 cu (4.10) = 0.52172715
MRc (4.17) = 6.3768E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o

- N, 1, 2, v normalised to bo*do, instead of b*d
- - parameters of confined concrete, fcc, cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 *cu (4.11) = 0.5604845
MRo (4.18) = 4.7738E+008
MRo < 0.8*MRc
--->
 u = cu (unconfined full section) = 4.8346386E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 339150.739

Calculation of Shear Strength at edge 1, Vr1 = 339150.739
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
 VCol0 = 339150.739
 knl = 1 (zero step-static loading)

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

    = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
     Mu = 2.0345E+006
     Vu = 2.3476251E-006
  d = 0.8*h = 320.00
  Nu = 1.8026E+006
  Ag = 80000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 471238.898
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 471238.898
  Vs,j1 = 314159.265 is calculated for section web jacket, with:
    d = 320.00
    Av = 157079.633
    fy = 625.00
    s = 100.00
  Vs,j1 is multiplied by Col,j1 = 1.00
    s/d = 0.3125
  Vs,j2 = 157079.633 is calculated for section flange jacket, with:
    d = 160.00
    Av = 157079.633
    fy = 625.00
    s = 100.00
  Vs,j2 is multiplied by Col,j2 = 1.00

s/d = 0.625
  Vs,core = Vs,c1 + Vs,c2 = 0.00
   Vs,c1 = 0.00 is calculated for section web core, with:
     d = 240.00
     Av = 100530.965
     fy = 500.00
     s = 250.00
   Vs,c1 is multiplied by   Col,c1 = 0.00
     s/d = 1.04167
   Vs,c2 = 0.00 is calculated for section flange core, with:
     d = 80.00
     Av = 100530.965
     fy = 500.00
     s = 250.00
   Vs,c2 is multiplied by   Col,c2 = 0.00
     s/d = 3.125
   Vf ((11-3)-(11.4), ACI 440) = 0.00
   From (11-11), ACI 440: Vs + Vf <= 212577.225
     bw = 200.00

Calculation of Shear Strength at edge 2, Vr2 = 339150.739
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 339150.739
  knl = 1 (zero step-static loading)

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

     = 1 (normal-weight concrete)
   Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
     Mu = 6739.685
     Vu = 2.3476251E-006
  d = 0.8*h = 320.00
  Nu = 1.8026E+006
  Ag = 80000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 471238.898
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 471238.898
  Vs,j1 = 314159.265 is calculated for section web jacket, with:
     d = 320.00
     Av = 157079.633
     fy = 625.00
     s = 100.00
   Vs,j1 is multiplied by   Col,j1 = 1.00
     s/d = 0.3125
   Vs,j2 = 157079.633 is calculated for section flange jacket, with:
     d = 160.00
     Av = 157079.633
     fy = 625.00
     s = 100.00
   Vs,j2 is multiplied by   Col,j2 = 1.00
     s/d = 0.625
  Vs,core = Vs,c1 + Vs,c2 = 0.00
   Vs,c1 = 0.00 is calculated for section web core, with:
     d = 240.00
     Av = 100530.965
     fy = 500.00
     s = 250.00
   Vs,c1 is multiplied by   Col,c1 = 0.00
     s/d = 1.04167
   Vs,c2 = 0.00 is calculated for section flange core, with:
     d = 80.00
     Av = 100530.965
     fy = 500.00

```
    s = 250.00
  Vs,c2 is multiplied by   Col,c2 = 0.00
    s/d = 3.125
  Vf ((11-3)-(11.4), ACI 440) = 0.00
  From (11-11), ACI 440: Vs + Vf <= 212577.225
    bw = 200.00
------------------------------------------------------------
------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column JLC1 of floor 1
At local axis: 3


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


Start Of Calculation of Shear Capacity ratio for element: column JLC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjlcs

Constant Properties
------------------------------------------------------------
Knowledge Factor,    = 0.90
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 30.00
New material of Secondary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 18.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 500.00
Concrete Elasticity, Ec = 19940.411
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
Jacket
New material: Steel Strength, fs = 1.25*fsm = 781.25
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 625.00
############################################################
Max Height, Hmax = 400.00
Min Height, Hmin = 200.00
Max Width, Wmax = 400.00
Min Width, Wmin = 200.00
Jacket Thickness, tj = 50.00
Cover Thickness, c = 15.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping
------------------------------------------------------------


Stepwise Properties
------------------------------------------------------------
At local axis: 2
EDGE -A-
Shear Force, Va = -3.6347847E-006
EDGE -B-
Shear Force, Vb = 3.6347847E-006
BOTH EDGES
```

Axial Force, F = -1.8026E+006
Longitudinal Reinforcement Area Distribution (in 2 divisions)
     -Tension: Aslt = 0.00
   -Compression: Aslc = 5353.274
Longitudinal Reinforcement Area Distribution (in 3 divisions)
     -Tension: Asl,ten = 1137.257
   -Compression: Asl,com = 2208.54
      -Middle: Asl,mid = 2007.478

Calculation of Shear Capacity ratio , Ve/Vr = 1.18753
Member Controlled by Shear (Ve/Vr > 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 402750.026
with
Mpr1 = Max(Mu1+ , Mu1-) = 6.0413E+008
  Mu1+ = 6.0413E+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- = 5.4612E+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-) = 6.0413E+008
  Mu2+ = 6.0413E+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- = 5.4612E+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 = 1.2613948E-005
Mu = 6.0413E+008
----
with full section properties:
  b = 400.00
  d = 367.00
  d' = 33.00
  v = 0.40931126
    N = 1.8026E+006
  fc = 30.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00925707
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00925707
      we (5.4c) = 0.0207149
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.33836562
        ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
        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,max1 = 89600.00 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 external perimeter hoops.
        Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
                is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                equal to half the clear spacing between external hoops.
        AnoConf1 = 43733.333 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
      ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
        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,max2 = 45264.00 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 internal perimeter hoops.
Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 32309.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205

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

----

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
Lstir1 (Length of stirrups along Y) = 1040.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
Lstir2 (Length of stirrups along Y) = 768.00
Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
Lstir1 (Length of stirrups along X) = 1040.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
Lstir2 (Length of stirrups along X) = 768.00
Astir2 (stirrups area) = 50.26548

Asec = 120000.00
s1 = 100.00
s2 = 250.00
fywe1 = 781.25
fywe2 = 625.00
fce = 30.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.0025
sh1 = 0.008
ft1 = 886.7403
fy1 = 738.9503
su1 = 0.032
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 = 1.00
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, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 738.9503
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 898.293
fy2 = 748.5775
su2 = 0.032
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 = 1.00
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, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 748.5775
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025

shv = 0.008
ftv = 894.3662
fyv = 745.3052
suv = 0.032
 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 = 1.00
 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, ASCE 41-17.
  with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.19082108
 2 = Asl,com/(b*d)*(fs2/fc) = 0.37540035
 v = Asl,mid/(b*d)*(fsv/fc) = 0.33973286
and confined core properties:
 b = 360.00
 d = 347.00
 d' = 13.00
 fcc (5A.2, TBDY) = 30.00
  cc (5A.5, TBDY) = 0.002
   c = confinement factor = 1.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.22424379
 2 = Asl,com/(b*d)*(fs2/fc) = 0.44115251
 v = Asl,mid/(b*d)*(fsv/fc) = 0.39923778
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
 ' satisfies Eq. (4.4)
--->
v < s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
 cu (4.10) = 0.37716748
MRc (4.17) = 7.0585E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
 - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
 - N, 1, 2, v normalised to bo*do, instead of b*d
 - - parameters of confined concrete, fcc, cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied

--->
  *cu (4.11) = 0.4569298
MRo (4.18) = 6.0413E+008
--->
  u =   cu (4.2) = 1.2613948E-005
Mu = MRo

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
  u = 3.1475172E-005
Mu = 5.4612E+008
----
with full section properties:
  b = 200.00
  d = 367.00
  d' = 33.00
  v = 0.81862252
    N = 1.8026E+006
  fc = 30.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00925707
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00925707
      we (5.4c) = 0.0207149
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.33836562
        ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
        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,max1 = 89600.00 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 external perimeter hoops.
        Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
           is calculated by reducing all the dimensions of the area Aconf,max1 by a length
           equal to half the clear spacing between external hoops.
        AnoConf1 = 43733.333 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
      ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
        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,max2 = 45264.00 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 internal perimeter hoops.
        Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
           is calculated by reducing all the dimensions of the area Aconf,max2 by a length
           equal to half the clear spacing between internal hoops.
        AnoConf2 = 32309.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
      psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
    Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
      ----
      psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
      psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
        Lstir1 (Length of stirrups along Y) = 1040.00
        Astir1 (stirrups area) = 78.53982

```
        psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
            Lstir2 (Length of stirrups along Y) = 768.00
            Astir2 (stirrups area) = 50.26548
    -------------------------------------------------------------------
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
            Lstir1 (Length of stirrups along X) = 1040.00
            Astir1 (stirrups area) = 78.53982
        psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
            Lstir2 (Length of stirrups along X) = 768.00
            Astir2 (stirrups area) = 50.26548
    -------------------------------------------------------------------
        Asec = 120000.00
        s1 = 100.00
        s2 = 250.00
        fywe1 = 781.25
        fywe2 = 625.00
        fce  = 30.00
    From ((5.A5), TBDY), TBDY:  cc = 0.002
        c  = confinement factor = 1.00
  y1 = 0.0025
  sh1 = 0.008
 ft1 = 898.293
 fy1 = 748.5775
  su1 = 0.032
    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 = 1.00
     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, ASCE 41-17.
      with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 748.5775
      with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.0025
  sh2 = 0.008
 ft2 = 886.7403
 fy2 = 738.9503
  su2 = 0.032
    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 = 1.00
     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, ASCE 41-17.
      with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 738.9503
      with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.0025
  shv = 0.008
 ftv = 894.3662
 fyv = 745.3052
  suv = 0.032
    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 = 1.00
     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, ASCE 41-17.
```

     with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
     with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.7508007
  2 = Asl,com/(b*d)*(fs2/fc) = 0.38164216
  v = Asl,mid/(b*d)*(fsv/fc) = 0.67946571
and confined core properties:
  b = 160.00
  d = 347.00
  d' = 13.00
  fcc (5A.2, TBDY) = 30.00
   cc (5A.5, TBDY) = 0.002
     c = confinement factor = 1.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.99259314
  2 = Asl,com/(b*d)*(fs2/fc) = 0.50454853
  v = Asl,mid/(b*d)*(fsv/fc) = 0.898285
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
 ' satisfies Eq. (4.4)
--->
v < s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is not satisfied
--->
 cu (4.11) = 0.80138156
MRc (4.18) = 5.4612E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N, 1, 2, v normalised to bo*do, instead of b*d
  - - parameters of confined concrete, fcc, cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 *cu (4.11) = 0.80674817
MRo (4.18) = 2.8580E+008
MRo < 0.8*MRc
--->
 u = cu (unconfined full section) = 3.1475172E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1


```
--------------------------------------------------------------------------
Calculation of Mu2+
--------------------------------------------------------------------------


--------------------------------------------------------------------------
Calculation of ultimate curvature  u according to 4.1, Biskinis/Fardis 2013:
  u = 1.2613948E-005
Mu = 6.0413E+008
--------------------------------------------------------------------------
with full section properties:
  b = 400.00
  d = 367.00
  d' = 33.00
  v = 0.40931126
    N = 1.8026E+006
  fc = 30.00
   co (5A.5, TBDY) = 0.002
  Final value of  cu:  cu* = shear_factor * Max( cu, cc) = 0.00925707
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY:  cu = 0.00925707
       we (5.4c) = 0.0207149
       ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.33836562
         ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
         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,max1 = 89600.00 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 external perimeter hoops.
         Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
                 is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                 equal to half the clear spacing between external hoops.
         AnoConf1 = 43733.333 is the unconfined external core area which is equal to  bi2/6 as defined at (A.2).
       ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
         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,max2 = 45264.00 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 internal perimeter hoops.
         Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
                 is calculated by reducing all the dimensions of the area Aconf,max2 by a length
                  equal to half the clear spacing between internal hoops.
         AnoConf2 = 32309.333 is the unconfined internal core area which is equal to  bi2/6 as defined at (A.2).
       psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
     Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
       ------------------------------------------------------------------
         psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
         psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
           Lstir1 (Length of stirrups along Y) = 1040.00
           Astir1 (stirrups area) = 78.53982
         psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
           Lstir2 (Length of stirrups along Y) = 768.00
           Astir2 (stirrups area) = 50.26548
       ------------------------------------------------------------------
         psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
         psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
           Lstir1 (Length of stirrups along X) = 1040.00
           Astir1 (stirrups area) = 78.53982
         psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
           Lstir2 (Length of stirrups along X) = 768.00
           Astir2 (stirrups area) = 50.26548
       ------------------------------------------------------------------
         Asec = 120000.00
```

```
              s1 = 100.00
              s2 = 250.00
          fywe1 = 781.25
          fywe2 = 625.00
            fce = 30.00
     From ((5.A5), TBDY), TBDY:  cc = 0.002
          c  = confinement factor = 1.00
   y1 = 0.0025
  sh1 = 0.008
  ft1 = 886.7403
  fy1 = 738.9503
   su1 = 0.032
     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 = 1.00
      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, ASCE 41-17.
       with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 738.9503
       with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
   y2 = 0.0025
  sh2 = 0.008
  ft2 = 898.293
  fy2 = 748.5775
   su2 = 0.032
     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 = 1.00
      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, ASCE 41-17.
       with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 748.5775
       with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
   yv = 0.0025
  shv = 0.008
  ftv = 894.3662
  fyv = 745.3052
   suv = 0.032
     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 = 1.00
      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, ASCE 41-17.
       with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
       with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.19082108
    2 = Asl,com/(b*d)*(fs2/fc) = 0.37540035
    v = Asl,mid/(b*d)*(fsv/fc) = 0.33973286
and confined core properties:
  b = 360.00
  d = 347.00
  d' = 13.00
 fcc (5A.2, TBDY) = 30.00
   cc (5A.5, TBDY) = 0.002
      c = confinement factor = 1.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.22424379
```

    2 = Asl,com/(b*d)*(fs2/fc) = 0.44115251
    v = Asl,mid/(b*d)*(fsv/fc) = 0.39923778
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
  ' satisfies Eq. (4.4)
--->
v < s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
 cu (4.10) = 0.37716748
MRc (4.17) = 7.0585E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N, 1, 2, v normalised to bo*do, instead of b*d
  - - parameters of confined concrete, fcc, cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 *cu (4.11) = 0.4569298
MRo (4.18) = 6.0413E+008
--->
  u = cu (4.2) = 1.2613948E-005
Mu = MRo

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
  u = 3.1475172E-005
Mu = 5.4612E+008
----
with full section properties:
  b = 200.00
  d = 367.00
  d' = 33.00
  v = 0.81862252

N = 1.8026E+006
  fc = 30.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00925707
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: cu = 0.00925707
        we (5.4c) = 0.0207149
        ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.33836562
           ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
           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,max1 = 89600.00 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 external perimeter hoops.
           Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
                   is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                   equal to half the clear spacing between external hoops.
           AnoConf1 = 43733.333 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
        ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
           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,max2 = 45264.00 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 internal perimeter hoops.
           Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
                   is calculated by reducing all the dimensions of the area Aconf,max2 by a length
                   equal to half the clear spacing between internal hoops.
           AnoConf2 = 32309.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
        psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
     Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
     ----
        psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
           Lstir1 (Length of stirrups along Y) = 1040.00
           Astir1 (stirrups area) = 78.53982
        psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
           Lstir2 (Length of stirrups along Y) = 768.00
           Astir2 (stirrups area) = 50.26548
     ----
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
           Lstir1 (Length of stirrups along X) = 1040.00
           Astir1 (stirrups area) = 78.53982
        psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
           Lstir2 (Length of stirrups along X) = 768.00
           Astir2 (stirrups area) = 50.26548

           Asec = 120000.00
           s1 = 100.00
           s2 = 250.00
        fywe1 = 781.25
        fywe2 = 625.00
        fce = 30.00
     From ((5.A5), TBDY), TBDY: cc = 0.002
         c = confinement factor = 1.00
   y1 = 0.0025
   sh1 = 0.008
  ft1 = 898.293
  fy1 = 748.5775
   su1 = 0.032
     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 = 1.00
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, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 748.5775
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 886.7403
fy2 = 738.9503
su2 = 0.032
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 = 1.00
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, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 738.9503
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 894.3662
fyv = 745.3052
suv = 0.032
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 = 1.00
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, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.7508007
2 = Asl,com/(b*d)*(fs2/fc) = 0.38164216
v = Asl,mid/(b*d)*(fsv/fc) = 0.67946571
and confined core properties:
b = 160.00
d = 347.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.99259314
2 = Asl,com/(b*d)*(fs2/fc) = 0.50454853
v = Asl,mid/(b*d)*(fsv/fc) = 0.898285
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
' satisfies Eq. (4.4)
--->

ε v < ε s,y1 - LHS eq.(4.7) is not satisfied
--->
ε v < ε vc,y1 - RHS eq.(4.6) is not satisfied
--->
ξcu (4.11) = 0.80138156
MRc (4.18) = 5.4612E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N, μ1, μ2, ν normalised to bo*do, instead of b*d
  - σ-ε parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
ξ*cu (4.11) = 0.80674817
MRo (4.18) = 2.8580E+008
MRo < 0.8*MRc
--->
φu = φcu (unconfined full section) = 3.1475172E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 339150.739

Calculation of Shear Strength at edge 1, Vr1 = 339150.739
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 339150.739
  knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

  λ = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
    Mu = 6.7415E+007
    Vu = 3.6347847E-006
  d = 0.8*h = 320.00
  Nu = 1.8026E+006
  Ag = 80000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 471238.898
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 471238.898
  Vs,j1 = 157079.633 is calculated for section web jacket, with:
    d = 160.00
    Av = 157079.633

```
       fy = 625.00
       s = 100.00
    Vs,j1 is multiplied by   Col,j1 = 1.00
       s/d = 0.625
    Vs,j2 = 314159.265 is calculated for section flange jacket, with:
       d = 320.00
       Av = 157079.633
       fy = 625.00
       s = 100.00
    Vs,j2 is multiplied by   Col,j2 = 1.00
       s/d = 0.3125
   Vs,core = Vs,c1 + Vs,c2 = 0.00
    Vs,c1 = 0.00 is calculated for section web core, with:
       d = 80.00
       Av = 100530.965
       fy = 500.00
       s = 250.00
    Vs,c1 is multiplied by   Col,c1 = 0.00
       s/d = 3.125
    Vs,c2 = 0.00 is calculated for section flange core, with:
       d = 240.00
       Av = 100530.965
       fy = 500.00
       s = 250.00
    Vs,c2 is multiplied by   Col,c2 = 0.00
       s/d = 1.04167
    Vf ((11-3)-(11.4), ACI 440) = 0.00
    From (11-11), ACI 440: Vs + Vf <= 212577.225
       bw = 200.00
----------------------------------------------------------------
-----------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 339150.739
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
   VCol0 = 339150.739
   knl = 1 (zero step-static loading)
----------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
----------------------------------------------------------------
     = 1 (normal-weight concrete)
   Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
   M/Vd = 4.00
      Mu = 5.3429E+007
      Vu = 3.6347847E-006
   d = 0.8*h = 320.00
   Nu = 1.8026E+006
   Ag = 80000.00
   From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 471238.898
   where:
   Vs,jacket = Vs,j1 + Vs,j2 = 471238.898
    Vs,j1 = 157079.633 is calculated for section web jacket, with:
       d = 160.00
       Av = 157079.633
       fy = 625.00
       s = 100.00
    Vs,j1 is multiplied by   Col,j1 = 1.00
       s/d = 0.625
    Vs,j2 = 314159.265 is calculated for section flange jacket, with:
       d = 320.00
       Av = 157079.633
       fy = 625.00
       s = 100.00
    Vs,j2 is multiplied by   Col,j2 = 1.00
       s/d = 0.3125
   Vs,core = Vs,c1 + Vs,c2 = 0.00
    Vs,c1 = 0.00 is calculated for section web core, with:
```

```
        d = 80.00
        Av = 100530.965
        fy = 500.00
        s = 250.00
    Vs,c1 is multiplied by   Col,c1 = 0.00
        s/d = 3.125
    Vs,c2 = 0.00 is calculated for section flange core, with:
        d = 240.00
        Av = 100530.965
        fy = 500.00
        s = 250.00
    Vs,c2 is multiplied by   Col,c2 = 0.00
        s/d = 1.04167
    Vf ((11-3)-(11.4), ACI 440) = 0.00
    From (11-11), ACI 440: Vs + Vf <= 212577.225
        bw = 200.00
--------------------------------------------------------------
--------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column JLC1 of floor 1
At local axis: 2


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


Start Of Calculation of Chord Rotation Capacity for element: column JLC1 of floor 1
At local axis: 2
Integration Section: (b)
Section Type: rcjlcs

Constant Properties
--------------------------------------------------------------
Knowledge Factor,   = 0.90
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 30.00
New material of Secondary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 18.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 500.00
Concrete Elasticity, Ec = 19940.411
Steel Elasticity, Es = 200000.00
Max Height, Hmax = 400.00
Min Height, Hmin = 200.00
Max Width, Wmax = 400.00
Min Width, Wmin = 200.00
Jacket Thickness, tj = 50.00
Cover Thickness, c = 15.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lb/ld>=1)
No FRP Wrapping
--------------------------------------------------------------

Stepwise Properties
--------------------------------------------------------------
Bending Moment, M = 18804.004
Shear Force, V2 = 97644.268
Shear Force, V3 = 30.34672
Axial Force, F = -1.8003E+006
```

Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 5353.274
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 2208.54
     -Compression: Asl,com = 1137.257
        -Middle: Asl,mid = 2007.478
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,jacket = 1746.726
     -Compression: Asl,com,jacket = 829.3805
        -Middle: Asl,mid,jacket = 1545.664
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,core = 461.8141
     -Compression: Asl,com,core = 307.8761
        -Middle: Asl,mid,core = 461.8141
Mean Diameter of Tension Reinforcement, DbL = 16.60

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $\theta u,R =$ $*$ $\theta u = 0.00389461$
 $\theta u = \theta y + \theta p = 0.00432734$

 - Calculation of θy -

 $\theta y = (My*Ls/3)/EIeff = 0.00432734$ ((4.29),Biskinis Phd))
 My = 5.2276E+008
 Ls = M/V (with Ls > 0.1*L and Ls < 2*L) = 619.6389
 From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 2.4951E+013
    factor = 0.70
       Ag = 120000.00
       Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00
       N = 1.8003E+006
    Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.5645E+013

Calculation of Yielding Moment My

Calculation of θy and My according to Annex 7 -

Assuming neutral axis out of flange ($\xi y > t/d$, compression zone NOT rectangular)
extended expressions (2.1)-(2.7) of Biskinis-Fardis (2009) are adopted with:
flange width, b = 400.00
web width, bw = 200.00
flange thickness, t = 200.00

 $\phi y = Min(\phi y\_ten, \phi y\_com)$
 $\phi y\_ten = 1.6044767E-005$
 with fy = 596.2441
    d = 367.00
     $\xi y = 0.49371549$
    A = 0.18421443
    B = 0.10663695
     with pt = 0.01504455
        pc = 0.00774698
        pv = 0.01367492
        N = 1.8003E+006
        b = 400.00
         " = 0.08991826
  $\phi y\_comp = 1.0454056E-005$
 with fc = 30.00
    Ec = 25742.96
     $\xi y = 0.54674444$
    A = 0.08461246
    B = 0.06549972

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with Es = 200000.00
CONFIRMATION: y = 0.54674444 > t/d

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

 - 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/VColOE = 1.44151
  d = d_external = 367.00
  s = s_external = 100.00
 - t = s1 + s2 + 2*tf/bw*(ffe/fs) = 0.00809358
  jacket: s1 = Av1*Lstir1/(s1*Ag) = 0.00680678
       Av1 = 78.53982, is the area of every stirrup parallel to loading (shear) direction
       Lstir1 = 1040.00, is the total Length of all stirrups parallel to loading (shear) direction
       s1 = 100.00
  core: s2 = Av2*Lstir2/(s2*Ag) = 0.0012868
       Av2 = 50.26548, is the area of every stirrup parallel to loading (shear) direction
       Lstir2 = 768.00, is the total Length of all stirrups parallel to loading (shear) direction
       s2 = 250.00
  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.
  For the normalisation fs of jacket is used.
   NUD = 1.8003E+006
   Ag = 120000.00
   f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 25.00
   fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein =
596.2441
   fytE = (fy_ext_Trans_Reinf* s1+fy_int_Trans_Reinf* s2)/(s1+ s2) = 605.1263
pl = Area_Tot_Long_Rein/(b*d) = 0.03646644
  b = 400.00
  d = 367.00
   f'cE = 25.00

End Of Calculation of Chord Rotation Capacity for element: column JLC1 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 50 and 51)

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (3)

Start Of Calculation of Shear Capacity for element: column JLC1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rcjlcs

Constant Properties

Knowledge Factor,   = 0.90
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 12.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 19940.411
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, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 30.00
New material: Steel Strength, fs = fsm = 625.00
Existing Column
Existing material: Concrete Strength, fc = fcm = 18.00
Existing material: Steel Strength, fs = fsm = 500.00
###
Max Height, Hmax = 400.00
Min Height, Hmin = 200.00
Max Width, Wmax = 400.00
Min Width, Wmin = 200.00
Jacket Thickness, tj = 50.00
Cover Thickness, c = 15.00
Element Length, L = 3000.00

Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min = lb/ld >=1)
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = 1.8819E+007
Shear Force, Va = -30.34672
EDGE -B-
Bending Moment, Mb = 18804.004
Shear Force, Vb = 30.34672
BOTH EDGES
Axial Force, F = -1.8003E+006
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 5353.274
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 2208.54
      -Compression: Asl,com = 1137.257
          -Middle: Asl,mid = 2007.478
Mean Diameter of Tension Reinforcement, DbL,ten = 16.60

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR =   *Vn = 360068.846
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 400076.496
  VCol = 400076.496
  knl = 1.00
     displacement_ductility_demand = 0.01979823

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

    = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 16.66667, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
     Mu = 18804.004
     Vu = 30.34672
  d = 0.8*h = 320.00
  Nu = 1.8003E+006
  Ag = 80000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 376991.118
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 376991.118
  Vs,j1 = 251327.412 is calculated for section web jacket, with:
     d = 320.00
     Av = 157079.633
     fy = 500.00
     s = 100.00
  Vs,j1 is multiplied by   Col,j1 = 1.00
     s/d = 0.3125
  Vs,j2 = 125663.706 is calculated for section flange jacket, with:
     d = 160.00
     Av = 157079.633
     fy = 500.00
     s = 100.00
  Vs,j2 is multiplied by   Col,j2 = 1.00
     s/d = 0.625
  Vs,core = Vs,c1 + Vs,c2 = 0.00

```
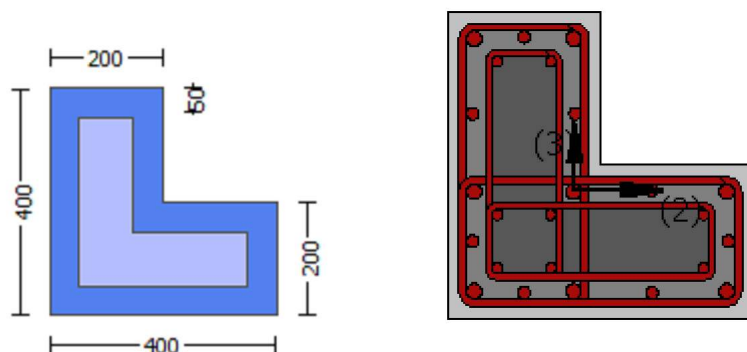   Vs,c1 = 0.00 is calculated for section web core, with:
      d = 240.00
      Av = 100530.965
      fy = 400.00
      s = 250.00
    Vs,c1 is multiplied by   Col,c1 = 0.00
      s/d = 1.04167
    Vs,c2 = 0.00 is calculated for section flange core, with:
      d = 80.00
      Av = 100530.965
      fy = 400.00
      s = 250.00
    Vs,c2 is multiplied by   Col,c2 = 0.00
      s/d = 3.125
    Vf ((11-3)-(11.4), ACI 440) = 0.00
    From (11-11), ACI 440: Vs + Vf <= 173568.578
      bw = 200.00
--------------------------------------------------------------


--------------------------------------------------------------
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    = 8.5673666E-005
  y = (My*Ls/3)/Eleff = 0.00432734 ((4.29),Biskinis Phd))
  My = 5.2276E+008
  Ls = M/V (with Ls > 0.1*L and Ls < 2*L) = 619.6389
  From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 2.4951E+013
     factor = 0.70
        Ag = 120000.00
        Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00
        N = 1.8003E+006
     Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.5645E+013
--------------------------------------------------------------
--------------------------------------------------------------


Calculation of Yielding Moment My
--------------------------------------------------------------
Calculation of   y and My according to Annex 7   -
--------------------------------------------------------------
Assuming neutral axis out of flange (  y > t/d, compression zone NOT rectangular)
extended expressions (2.1)-(2.7) of Biskinis-Fardis (2009) are adopted with:
flange width, b = 400.00
web width, bw = 200.00
flange thickness, t = 200.00
--------------------------------------------------------------
  y = Min(  y_ten,  y_com)
  y_ten = 1.6044767E-005
 with fy = 596.2441
     d = 367.00
      y = 0.49371549
     A = 0.18421443
     B = 0.10663695
      with pt = 0.01504455
         pc = 0.00774698
         pv = 0.01367492
         N = 1.8003E+006
         b = 400.00
          " = 0.08991826
  y_comp = 1.0454056E-005
 with fc = 30.00
     Ec = 25742.96
      y = 0.54674444
     A = 0.08461246
     B = 0.06549972
```

with Es = 200000.00
CONFIRMATION: y = 0.54674444 > t/d

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

End Of Calculation of Shear Capacity for element: column JLC1 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 50 and 51)

Analysis: Uniform +X

Check: Chord rotation capacity (u)

Edge: End

Local Axis: (3)

Start Of Calculation of Shear Capacity ratio for element: column JLC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcjlcs

Constant Properties

Knowledge Factor,   = 0.90
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 30.00
New material of Secondary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00
Existing Column

Existing material of Secondary Member: Concrete Strength, fc = fcm = 18.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 500.00
Concrete Elasticity, Ec = 19940.411
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
Jacket
New material: Steel Strength, fs = 1.25*fsm = 781.25
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 625.00
##
Max Height, Hmax = 400.00
Min Height, Hmin = 200.00
Max Width, Wmax = 400.00
Min Width, Wmin = 200.00
Jacket Thickness, tj = 50.00
Cover Thickness, c = 15.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = 2.3476251E-006
EDGE -B-
Shear Force, Vb = -2.3476251E-006
BOTH EDGES
Axial Force, F = -1.8026E+006
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
    -Compression: Aslc = 5353.274
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 2208.54
    -Compression: Asl,com = 1137.257
        -Middle: Asl,mid = 2007.478

Calculation of Shear Capacity ratio , Ve/Vr = 1.44151
Member Controlled by Shear (Ve/Vr > 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 488890.189
with
Mpr1 = Max(Mu1+ , Mu1-) = 7.3334E+008
   Mu1+ = 7.3334E+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- = 6.3768E+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-) = 7.3334E+008
   Mu2+ = 7.3334E+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- = 6.3768E+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+

```
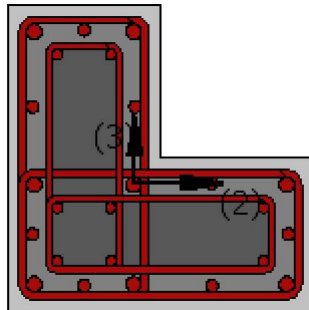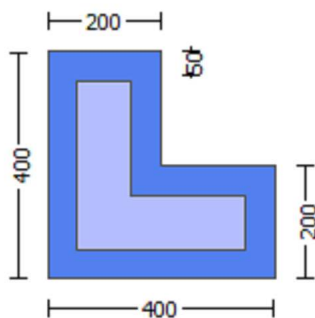-----------------------------------------------------------------------------
Calculation of ultimate curvature  u according to 4.1, Biskinis/Fardis 2013:
  u = 4.2207094E-005
Mu = 7.3334E+008
-----------------------------------------------------------------------------
with full section properties:
  b = 400.00
  d = 367.00
  d' = 33.00
  v = 0.40931126
    N = 1.8026E+006
  fc = 30.00
   co (5A.5, TBDY) = 0.002
  Final value of  cu:  cu* = shear_factor * Max( cu, cc) = 0.00925707
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY:  cu = 0.00925707
      we (5.4c) = 0.0207149
      ase ((5.4d), TBDY) = (ase1*Aext+ ase2*Aint)/Asec = 0.33836562
        ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
        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,max1 = 89600.00 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 external perimeter hoops.
        Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
              is calculated by reducing all the dimensions of the area Aconf,max1 by a length
              equal to half the clear spacing between external hoops.
      AnoConf1 = 43733.333 is the unconfined external core area which is equal to  bi2/6 as defined at (A.2).
      ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
        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,max2 = 45264.00 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 internal perimeter hoops.
        Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
              is calculated by reducing all the dimensions of the area Aconf,max2 by a length
              equal to half the clear spacing between internal hoops.
      AnoConf2 = 32309.333 is the unconfined internal core area which is equal to  bi2/6 as defined at (A.2).
    psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
  Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
      ------------------------------------------------------------------
      psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
      psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
        Lstir1 (Length of stirrups along Y) = 1040.00
        Astir1 (stirrups area) = 78.53982
      psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
        Lstir2 (Length of stirrups along Y) = 768.00
        Astir2 (stirrups area) = 50.26548
      ------------------------------------------------------------------
      psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
      psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
        Lstir1 (Length of stirrups along X) = 1040.00
        Astir1 (stirrups area) = 78.53982
      psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
        Lstir2 (Length of stirrups along X) = 768.00
        Astir2 (stirrups area) = 50.26548
      ------------------------------------------------------------------
        Asec = 120000.00
        s1 = 100.00
        s2 = 250.00
      fywe1 = 781.25
```

```
        fywe2 = 625.00
        fce  = 30.00
      From ((5.A5), TBDY), TBDY:  cc = 0.002
          c = confinement factor = 1.00
    y1 = 0.0025
   sh1 = 0.008
  ft1 = 898.293
  fy1 = 748.5775
   su1 = 0.032
      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 = 1.00
       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, ASCE 41-17.
       with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 748.5775
       with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
    y2 = 0.0025
   sh2 = 0.008
  ft2 = 886.7403
  fy2 = 738.9503
   su2 = 0.032
      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 = 1.00
       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, ASCE 41-17.
       with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 738.9503
       with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
    yv = 0.0025
   shv = 0.008
  ftv = 894.3662
  fyv = 745.3052
   suv = 0.032
      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 = 1.00
       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, ASCE 41-17.
       with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
       with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.37540035
    2 = Asl,com/(b*d)*(fs2/fc) = 0.19082108
    v = Asl,mid/(b*d)*(fsv/fc) = 0.33973286
 and confined core properties:
   b = 360.00
   d = 347.00
   d' = 13.00
  fcc (5A.2, TBDY) = 30.00
   cc (5A.5, TBDY) = 0.002
      c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.44115251
    2 = Asl,com/(b*d)*(fs2/fc) = 0.22424379
    v = Asl,mid/(b*d)*(fsv/fc) = 0.39923778
 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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
  ' satisfies Eq. (4.4)
--->
v < s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
 cu (4.10) = 0.59761571
MRc (4.17) = 7.3334E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N, 1, 2, v normalised to bo*do, instead of b*d
  - - parameters of confined concrete, fcc, cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 *cu (4.11) = 0.62879536
MRo (4.18) = 4.5866E+008
MRo < 0.8*MRc
--->
 u = cu (unconfined full section) = 4.2207094E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 u = 4.8346386E-005
Mu = 6.3768E+008
----
with full section properties:
 b = 200.00
 d = 367.00
 d' = 33.00
 v = 0.81862252
    N = 1.8026E+006
 fc = 30.00

co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00925707
   The Shear_factor is considered equal to 1 (pure moment strength)
   From (5.4b), TBDY: cu = 0.00925707
     we (5.4c) = 0.0207149
     ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.33836562
       ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
       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,max1 = 89600.00 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 external perimeter hoops.
       Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
           is calculated by reducing all the dimensions of the area Aconf,max1 by a length
           equal to half the clear spacing between external hoops.
       AnoConf1 = 43733.333 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
     ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
       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,max2 = 45264.00 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 internal perimeter hoops.
       Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
           is calculated by reducing all the dimensions of the area Aconf,max2 by a length
           equal to half the clear spacing between internal hoops.
       AnoConf2 = 32309.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
     psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
   Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
     ----
     psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
     psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
       Lstir1 (Length of stirrups along Y) = 1040.00
       Astir1 (stirrups area) = 78.53982
     psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
       Lstir2 (Length of stirrups along Y) = 768.00
       Astir2 (stirrups area) = 50.26548
     ----
     psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
     psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
       Lstir1 (Length of stirrups along X) = 1040.00
       Astir1 (stirrups area) = 78.53982
     psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
       Lstir2 (Length of stirrups along X) = 768.00
       Astir2 (stirrups area) = 50.26548

      Asec = 120000.00
      s1 = 100.00
      s2 = 250.00
     fywe1 = 781.25
     fywe2 = 625.00
     fce = 30.00
   From ((5.A5), TBDY), TBDY: cc = 0.002
     c = confinement factor = 1.00
 y1 = 0.0025
 sh1 = 0.008
ft1 = 886.7403
fy1 = 738.9503
 su1 = 0.032
   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 = 1.00

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, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 738.9503
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 898.293
fy2 = 748.5775
su2 = 0.032
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 = 1.00
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, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 748.5775
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 894.3662
fyv = 745.3052
suv = 0.032
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 = 1.00
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, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.38164216
2 = Asl,com/(b*d)*(fs2/fc) = 0.7508007
v = Asl,mid/(b*d)*(fsv/fc) = 0.67946571
and confined core properties:
b = 160.00
d = 347.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.50454853
2 = Asl,com/(b*d)*(fs2/fc) = 0.99259314
v = Asl,mid/(b*d)*(fsv/fc) = 0.898285
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
' satisfies Eq. (4.4)
--->
v < s,y1 - LHS eq.(4.7) is not satisfied
--->

v < vc,y1 - RHS eq.(4.6) is satisfied
--->
 cu (4.10) = 0.52172715
MRc (4.17) = 6.3768E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N, 1, 2, v normalised to bo*do, instead of b*d
  - - parameters of confined concrete, fcc, cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 *cu (4.11) = 0.5604845
MRo (4.18) = 4.7738E+008
MRo < 0.8*MRc
--->
 u = cu (unconfined full section) = 4.8346386E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 4.2207094E-005
Mu = 7.3334E+008
----
with full section properties:
  b = 400.00
  d = 367.00
  d' = 33.00
  v = 0.40931126
    N = 1.8026E+006
  fc = 30.00
  co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00925707
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00925707
      we (5.4c) = 0.0207149
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.33836562
        ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
        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,max1 = 89600.00 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 external perimeter hoops.
Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max1 by a length
equal to half the clear spacing between external hoops.
AnoConf1 = 43733.333 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
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,max2 = 45264.00 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 internal perimeter hoops.
Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 32309.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
Lstir1 (Length of stirrups along Y) = 1040.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
Lstir2 (Length of stirrups along Y) = 768.00
Astir2 (stirrups area) = 50.26548
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
Lstir1 (Length of stirrups along X) = 1040.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
Lstir2 (Length of stirrups along X) = 768.00
Astir2 (stirrups area) = 50.26548

Asec = 120000.00
s1 = 100.00
s2 = 250.00
fywe1 = 781.25
fywe2 = 625.00
fce = 30.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.0025
sh1 = 0.008
ft1 = 898.293
fy1 = 748.5775
su1 = 0.032
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 = 1.00
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, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 748.5775
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 886.7403
fy2 = 738.9503
su2 = 0.032
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 = 1.00
   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, ASCE 41-17.
   with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 738.9503
   with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
 yv = 0.0025
 shv = 0.008
ftv = 894.3662
fyv = 745.3052
 suv = 0.032
  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 = 1.00
   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, ASCE 41-17.
   with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
   with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.37540035
  2 = Asl,com/(b*d)*(fs2/fc) = 0.19082108
  v = Asl,mid/(b*d)*(fsv/fc) = 0.33973286
and confined core properties:
  b = 360.00
  d = 347.00
  d' = 13.00
  fcc (5A.2, TBDY) = 30.00
   cc (5A.5, TBDY) = 0.002
     c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.44115251
    2 = Asl,com/(b*d)*(fs2/fc) = 0.22424379
    v = Asl,mid/(b*d)*(fsv/fc) = 0.39923778
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
 ' satisfies Eq. (4.4)
--->
v < s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
 cu (4.10) = 0.59761571
MRc (4.17) = 7.3334E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N, 1, 2, v normalised to bo*do, instead of b*d
  - - parameters of confined concrete, fcc, cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->

v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 *cu (4.11) = 0.62879536
MRo (4.18) = 4.5866E+008
MRo < 0.8*MRc
--->
  u =   cu (unconfined full section) = 4.2207094E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 4.8346386E-005
Mu = 6.3768E+008
----
with full section properties:
  b = 200.00
  d = 367.00
  d' = 33.00
  v = 0.81862252
    N = 1.8026E+006
  fc = 30.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00925707
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00925707
       we (5.4c) = 0.0207149
       ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.33836562
          ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
          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,max1 = 89600.00 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 external perimeter hoops.
          Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
                 is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                 equal to half the clear spacing between external hoops.
          AnoConf1 = 43733.333 is the unconfined external core area which is equal to   bi2/6 as defined at (A.2).
        ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
          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,max2 = 45264.00 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 internal perimeter hoops.

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Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
            is calculated by reducing all the dimensions of the area Aconf,max2 by a length
            equal to half the clear spacing between internal hoops.
        AnoConf2 = 32309.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
        psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
    Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
        ----
        psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
            Lstir1 (Length of stirrups along Y) = 1040.00
            Astir1 (stirrups area) = 78.53982
        psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
            Lstir2 (Length of stirrups along Y) = 768.00
            Astir2 (stirrups area) = 50.26548
        ----
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
            Lstir1 (Length of stirrups along X) = 1040.00
            Astir1 (stirrups area) = 78.53982
        psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
            Lstir2 (Length of stirrups along X) = 768.00
            Astir2 (stirrups area) = 50.26548

        Asec = 120000.00
        s1 = 100.00
        s2 = 250.00
        fywe1 = 781.25
        fywe2 = 625.00
        fce = 30.00
    From ((5.A5), TBDY), TBDY: cc = 0.002
        c = confinement factor = 1.00
  y1 = 0.0025
  sh1 = 0.008
 ft1 = 886.7403
 fy1 = 738.9503
  su1 = 0.032
    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 = 1.00
     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, ASCE 41-17.
     with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 738.9503
     with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.0025
  sh2 = 0.008
 ft2 = 898.293
 fy2 = 748.5775
  su2 = 0.032
    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 = 1.00
     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, ASCE 41-17.
     with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 748.5775
     with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.0025
  shv = 0.008
 ftv = 894.3662

fyv = 745.3052
   suv = 0.032
      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 = 1.00
       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, ASCE 41-17.
       with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
       with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.38164216
    2 = Asl,com/(b*d)*(fs2/fc) = 0.7508007
    v = Asl,mid/(b*d)*(fsv/fc) = 0.67946571
and confined core properties:
   b = 160.00
   d = 347.00
   d' = 13.00
   fcc (5A.2, TBDY) = 30.00
    cc (5A.5, TBDY) = 0.002
       c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.50454853
    2 = Asl,com/(b*d)*(fs2/fc) = 0.99259314
    v = Asl,mid/(b*d)*(fsv/fc) = 0.898285
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
  ' satisfies Eq. (4.4)
--->
v <   s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
 cu (4.10) = 0.52172715
MRc (4.17) = 6.3768E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
   - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
   - N, 1, 2, v normalised to bo*do, instead of b*d
   - - parameters of confined concrete, fcc, cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 *cu (4.11) = 0.5604845

MRo (4.18) = 4.7738E+008
MRo < 0.8*MRc
--->
 u = cu (unconfined full section) = 4.8346386E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 339150.739

Calculation of Shear Strength at edge 1, Vr1 = 339150.739
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 339150.739
  knl = 1 (zero step-static loading)

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

    = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
    Mu = 2.0345E+006
    Vu = 2.3476251E-006
  d = 0.8*h = 320.00
  Nu = 1.8026E+006
  Ag = 80000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 471238.898
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 471238.898
  Vs,j1 = 314159.265 is calculated for section web jacket, with:
    d = 320.00
    Av = 157079.633
    fy = 625.00
    s = 100.00
  Vs,j1 is multiplied by Col,j1 = 1.00
    s/d = 0.3125
  Vs,j2 = 157079.633 is calculated for section flange jacket, with:
    d = 160.00
    Av = 157079.633
    fy = 625.00
    s = 100.00
  Vs,j2 is multiplied by Col,j2 = 1.00
    s/d = 0.625
  Vs,core = Vs,c1 + Vs,c2 = 0.00
  Vs,c1 = 0.00 is calculated for section web core, with:
    d = 240.00
    Av = 100530.965
    fy = 500.00
    s = 250.00
  Vs,c1 is multiplied by Col,c1 = 0.00
    s/d = 1.04167
  Vs,c2 = 0.00 is calculated for section flange core, with:
    d = 80.00
    Av = 100530.965
    fy = 500.00
    s = 250.00
  Vs,c2 is multiplied by Col,c2 = 0.00
    s/d = 3.125
  Vf ((11-3)-(11.4), ACI 440) = 0.00
  From (11-11), ACI 440: Vs + Vf <= 212577.225

```
    bw = 200.00
--------------------------------------------------------------

--------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 339150.739
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
   VCol0 = 339150.739
   knl = 1 (zero step-static loading)
--------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+  f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
--------------------------------------------------------------
     = 1 (normal-weight concrete)
   Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 < = 8.3
MPa (22.5.3.1, ACI 318-14)
   M/Vd = 4.00
      Mu = 6739.685
      Vu = 2.3476251E-006
   d = 0.8*h = 320.00
   Nu = 1.8026E+006
   Ag = 80000.00
   From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 471238.898
   where:
  Vs,jacket = Vs,j1 + Vs,j2 = 471238.898
   Vs,j1 = 314159.265 is calculated for section web jacket, with:
      d = 320.00
      Av = 157079.633
      fy = 625.00
      s = 100.00
   Vs,j1 is multiplied by   Col,j1 = 1.00
      s/d = 0.3125
   Vs,j2 = 157079.633 is calculated for section flange jacket, with:
      d = 160.00
      Av = 157079.633
      fy = 625.00
      s = 100.00
   Vs,j2 is multiplied by   Col,j2 = 1.00
      s/d = 0.625
  Vs,core = Vs,c1 + Vs,c2 = 0.00
   Vs,c1 = 0.00 is calculated for section web core, with:
      d = 240.00
      Av = 100530.965
      fy = 500.00
      s = 250.00
   Vs,c1 is multiplied by   Col,c1 = 0.00
      s/d = 1.04167
   Vs,c2 = 0.00 is calculated for section flange core, with:
      d = 80.00
      Av = 100530.965
      fy = 500.00
      s = 250.00
   Vs,c2 is multiplied by   Col,c2 = 0.00
      s/d = 3.125
   Vf ((11-3)-(11.4), ACI 440) = 0.00
   From (11-11), ACI 440: Vs + Vf < = 212577.225
      bw = 200.00
--------------------------------------------------------------
--------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column JLC1 of floor 1
At local axis: 3


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


Start Of Calculation of Shear Capacity ratio for element: column JLC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjlcs
```

Constant Properties

Knowledge Factor,   = 0.90
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, $fc = fcm = 30.00$
New material of Secondary Member: Steel Strength, $fs = fsm = 625.00$
Concrete Elasticity, $Ec = 25742.96$
Steel Elasticity, $Es = 200000.00$
Existing Column
Existing material of Secondary Member: Concrete Strength, $fc = fcm = 18.00$
Existing material of Secondary Member: Steel Strength, $fs = fsm = 500.00$
Concrete Elasticity, $Ec = 19940.411$
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
Jacket
New material: Steel Strength, $fs = 1.25*fsm = 781.25$
Existing Column
Existing material: Steel Strength, $fs = 1.25*fsm = 625.00$
##
Max Height, $Hmax = 400.00$
Min Height, $Hmin = 200.00$
Max Width, $Wmax = 400.00$
Min Width, $Wmin = 200.00$
Jacket Thickness, $tj = 50.00$
Cover Thickness, $c = 15.00$
Mean Confinement Factor overall section = 1.00
Element Length, $L = 3000.00$
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, $Va = -3.6347847E-006$
EDGE -B-
Shear Force, $Vb = 3.6347847E-006$
BOTH EDGES
Axial Force, $F = -1.8026E+006$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
     -Tension: $Aslt = 0.00$
   -Compression: $Aslc = 5353.274$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
     -Tension: $Asl,ten = 1137.257$
   -Compression: $Asl,com = 2208.54$
     -Middle: $Asl,mid = 2007.478$

Calculation of Shear Capacity ratio , $Ve/Vr = 1.18753$
Member Controlled by Shear ($Ve/Vr > 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $Ve = (Mpr1 + Mpr2)/ln = 402750.026$
with
$Mpr1 = Max(Mu1+ , Mu1-) = 6.0413E+008$
  $Mu1+ = 6.0413E+008$, 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- = 5.4612E+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-) = 6.0413E+008

  Mu2+ = 6.0413E+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- = 5.4612E+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 ϕ_u according to 4.1, Biskinis/Fardis 2013:
  ϕ_u = 1.2613948E-005
Mu = 6.0413E+008

----

with full section properties:
  b = 400.00
  d = 367.00
  d' = 33.00
  v = 0.40931126
    N = 1.8026E+006
  fc = 30.00
   ϵ_{co} (5A.5, TBDY) = 0.002
  Final value of ϵ_{cu}: ϵ_{cu}^* = shear_factor * Max(ϵ_{cu}, ϵ_{cc}) = 0.00925707
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: ϵ_{cu} = 0.00925707
      ω_{we} (5.4c) = 0.0207149
      α_{se} ((5.4d), TBDY) = (α_{se1}*Aext+ α_{se2}*Aint)/Asec = 0.33836562
        α_{se1} = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
        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,max1 = 89600.00 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 external perimeter hoops.
        Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
                is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                equal to half the clear spacing between external hoops.
      AnoConf1 = 43733.333 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
      α_{se2} (>= α_{se1}) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
        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,max2 = 45264.00 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 internal perimeter hoops.
        Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
                is calculated by reducing all the dimensions of the area Aconf,max2 by a length
                equal to half the clear spacing between internal hoops.
        AnoConf2 = 32309.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
      $\rho_{sh,min}$*Fywe = Min($\rho_{sh,x}$*Fywe , $\rho_{sh,y}$*Fywe) = 6.12205
    Expression (5.4d) for $\rho_{sh,min}$*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

      ρ_{sh_x}*Fywe = ρ_{sh1}*Fywe1+ ρ_{s2}*Fywe2 = 6.12205
      ρ_{sh1} ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
        Lstir1 (Length of stirrups along Y) = 1040.00
        Astir1 (stirrups area) = 78.53982
      ρ_{sh2} (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
        Lstir2 (Length of stirrups along Y) = 768.00
        Astir2 (stirrups area) = 50.26548

```
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
            Lstir1 (Length of stirrups along X) = 1040.00
            Astir1 (stirrups area) = 78.53982
        psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
            Lstir2 (Length of stirrups along X) = 768.00
            Astir2 (stirrups area) = 50.26548
    --------------------------------------------------------------
            Asec = 120000.00
            s1 = 100.00
            s2 = 250.00
            fywe1 = 781.25
            fywe2 = 625.00
            fce  = 30.00
      From ((5.A5), TBDY), TBDY:  cc = 0.002
            c = confinement factor = 1.00
   y1 = 0.0025
   sh1 = 0.008
 ft1 = 886.7403
 fy1 = 738.9503
   su1 = 0.032
      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 = 1.00
        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, ASCE 41-17.
        with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 738.9503
        with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
   y2 = 0.0025
   sh2 = 0.008
 ft2 = 898.293
 fy2 = 748.5775
   su2 = 0.032
      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 = 1.00
        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, ASCE 41-17.
        with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 748.5775
        with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
   yv = 0.0025
   shv = 0.008
 ftv = 894.3662
 fyv = 745.3052
   suv = 0.032
      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 = 1.00
        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, ASCE 41-17.
        with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
        with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.19082108
    2 = Asl,com/(b*d)*(fs2/fc) = 0.37540035
```

v = Asl,mid/(b*d)*(fsv/fc) = 0.33973286
and confined core properties:
  b = 360.00
  d = 347.00
  d' = 13.00
  fcc (5A.2, TBDY) = 30.00
   cc (5A.5, TBDY) = 0.002
      c = confinement factor = 1.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.22424379
   2 = Asl,com/(b*d)*(fs2/fc) = 0.44115251
   v = Asl,mid/(b*d)*(fsv/fc) = 0.39923778
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
  ' satisfies Eq. (4.4)
--->
v <   s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
 cu (4.10) = 0.37716748
MRc (4.17) = 7.0585E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N, 1, 2, v normalised to bo*do, instead of b*d
  - - parameters of confined concrete, fcc, cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 *cu (4.11) = 0.4569298
MRo (4.18) = 6.0413E+008
--->
 u =   cu (4.2) = 1.2613948E-005
Mu = MRo

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 3.1475172E-005
Mu = 5.4612E+008
----
with full section properties:
  b = 200.00
  d = 367.00
  d' = 33.00
  v = 0.81862252
    N = 1.8026E+006
  fc = 30.00
   εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.00925707
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: εcu = 0.00925707
       ωwe (5.4c) = 0.0207149
       αse ((5.4d), TBDY) = (αse1*Aext+αse2*Aint)/Asec = 0.33836562
          αse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
          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,max1 = 89600.00 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 external perimeter hoops.
          Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
                 is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                 equal to half the clear spacing between external hoops.
          AnoConf1 = 43733.333 is the unconfined external core area which is equal to Σbi2/6 as defined at (A.2).
       αse2 (>=αse1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
          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,max2 = 45264.00 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 internal perimeter hoops.
          Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
                 is calculated by reducing all the dimensions of the area Aconf,max2 by a length
                 equal to half the clear spacing between internal hoops.
          AnoConf2 = 32309.333 is the unconfined internal core area which is equal to Σbi2/6 as defined at (A.2).
       ρsh,min*Fywe = Min(ρsh,x*Fywe , ρsh,y*Fywe) = 6.12205
     Expression (5.4d) for ρsh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

          ρsh_x*Fywe = ρsh1*Fywe1+ρs2*Fywe2 = 6.12205
          ρsh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
             Lstir1 (Length of stirrups along Y) = 1040.00
             Astir1 (stirrups area) = 78.53982
          ρsh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
             Lstir2 (Length of stirrups along Y) = 768.00
             Astir2 (stirrups area) = 50.26548

          ρsh_y*Fywe = ρsh1*Fywe1+ρs2*Fywe2 = 6.12205
          ρsh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
             Lstir1 (Length of stirrups along X) = 1040.00
             Astir1 (stirrups area) = 78.53982
          ρsh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
             Lstir2 (Length of stirrups along X) = 768.00
             Astir2 (stirrups area) = 50.26548

             Asec = 120000.00
             s1 = 100.00
             s2 = 250.00
          fywe1 = 781.25
          fywe2 = 625.00
          fce = 30.00

From ((5.A5), TBDY), TBDY: cc = 0.002
        c = confinement factor = 1.00
   y1 = 0.0025
  sh1 = 0.008
 ft1 = 898.293
 fy1 = 748.5775
  su1 = 0.032
    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 = 1.00
     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, ASCE 41-17.
     with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 748.5775
     with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
   y2 = 0.0025
  sh2 = 0.008
 ft2 = 886.7403
 fy2 = 738.9503
  su2 = 0.032
    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 = 1.00
     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, ASCE 41-17.
     with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 738.9503
     with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
   yv = 0.0025
  shv = 0.008
 ftv = 894.3662
 fyv = 745.3052
  suv = 0.032
    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 = 1.00
     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, ASCE 41-17.
     with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
     with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.7508007
   2 = Asl,com/(b*d)*(fs2/fc) = 0.38164216
   v = Asl,mid/(b*d)*(fsv/fc) = 0.67946571
and confined core properties:
  b = 160.00
  d = 347.00
  d' = 13.00
  fcc (5A.2, TBDY) = 30.00
   cc (5A.5, TBDY) = 0.002
      c = confinement factor = 1.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.99259314
   2 = Asl,com/(b*d)*(fs2/fc) = 0.50454853
   v = Asl,mid/(b*d)*(fsv/fc) = 0.898285
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
  ' satisfies Eq. (4.4)
--->
v < s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is not satisfied
--->
 cu (4.11) = 0.80138156
MRc (4.18) = 5.4612E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N, 1, 2, v normalised to bo*do, instead of b*d
  - - parameters of confined concrete, fcc, cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 *cu (4.11) = 0.80674817
MRo (4.18) = 2.8580E+008
MRo < 0.8*MRc
--->
 u = cu (unconfined full section) = 3.1475172E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.2613948E-005
Mu = 6.0413E+008
----
with full section properties:
  b = 400.00
  d = 367.00
  d' = 33.00
  v = 0.40931126
     N = 1.8026E+006
  fc = 30.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00925707

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

From (5.4b), TBDY: c_u = 0.00925707

we (5.4c) = 0.0207149

ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.33836562

ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562

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,max1 = 89600.00 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 external perimeter hoops.

Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max1 by a length
equal to half the clear spacing between external hoops.

AnoConf1 = 43733.333 is the unconfined external core area which is equal to   bi2/6 as defined at (A.2).

ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562

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,max2 = 45264.00 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 internal perimeter hoops.

Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.

AnoConf2 = 32309.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).

psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205

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

---

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205

psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678

Lstir1 (Length of stirrups along Y) = 1040.00

Astir1 (stirrups area) = 78.53982

psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868

Lstir2 (Length of stirrups along Y) = 768.00

Astir2 (stirrups area) = 50.26548

---

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205

psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678

Lstir1 (Length of stirrups along X) = 1040.00

Astir1 (stirrups area) = 78.53982

psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868

Lstir2 (Length of stirrups along X) = 768.00

Astir2 (stirrups area) = 50.26548

Asec = 120000.00

s1 = 100.00

s2 = 250.00

fywe1 = 781.25

fywe2 = 625.00

fce = 30.00

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

c = confinement factor = 1.00

y1 = 0.0025

sh1 = 0.008

ft1 = 886.7403

fy1 = 738.9503

su1 = 0.032

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 = 1.00

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, ASCE 41-17.
 with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 738.9503
 with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 898.293
fy2 = 748.5775
su2 = 0.032
 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 = 1.00
 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, ASCE 41-17.
 with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 748.5775
 with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 894.3662
fyv = 745.3052
suv = 0.032
 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 = 1.00
 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, ASCE 41-17.
 with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
 with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.19082108
2 = Asl,com/(b*d)*(fs2/fc) = 0.37540035
v = Asl,mid/(b*d)*(fsv/fc) = 0.33973286
and confined core properties:
  b = 360.00
  d = 347.00
  d' = 13.00
  fcc (5A.2, TBDY) = 30.00
   cc (5A.5, TBDY) = 0.002
      c = confinement factor = 1.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.22424379
   2 = Asl,com/(b*d)*(fs2/fc) = 0.44115251
   v = Asl,mid/(b*d)*(fsv/fc) = 0.39923778
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
 ' satisfies Eq. (4.4)
--->
v <   s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->

εcu (4.10) = 0.37716748
MRc (4.17) = 7.0585E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N, ω1, ω2, v normalised to bo*do, instead of b*d
  - εϲ, εϲϲ parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
εᵤ*cu (4.11) = 0.4569298
MRo (4.18) = 6.0413E+008
--->
φu = φcu (4.2) = 1.2613948E-005
Mu = MRo

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 3.1475172E-005
Mu = 5.4612E+008
----
with full section properties:
  b = 200.00
  d = 367.00
  d' = 33.00
  v = 0.81862252
    N = 1.8026E+006
  fc = 30.00
  εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.00925707
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.00925707
      ωwe (5.4c) = 0.0207149
      αse ((5.4d), TBDY) = (αse1*Aext+αse2*Aint)/Asec = 0.33836562
        αse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
        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,max1 = 89600.00 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 external perimeter hoops.
        Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
              is calculated by reducing all the dimensions of the area Aconf,max1 by a length

equal to half the clear spacing between external hoops.

AnoConf1 = 43733.333 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).

ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562

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,max2 = 45264.00 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 internal perimeter hoops.

Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.

AnoConf2 = 32309.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).

psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205

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

----

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
Lstir1 (Length of stirrups along Y) = 1040.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
Lstir2 (Length of stirrups along Y) = 768.00
Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
Lstir1 (Length of stirrups along X) = 1040.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
Lstir2 (Length of stirrups along X) = 768.00
Astir2 (stirrups area) = 50.26548

Asec = 120000.00
s1 = 100.00
s2 = 250.00
fywe1 = 781.25
fywe2 = 625.00
fce = 30.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.0025
sh1 = 0.008
ft1 = 898.293
fy1 = 748.5775
su1 = 0.032
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 = 1.00
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, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 748.5775
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 886.7403
fy2 = 738.9503
su2 = 0.032
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 = 1.00

εsu2 = 0.4*εsu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: εsu2_nominal = 0.08,
For calculation of εsu2_nominal and εy2, εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, 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, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 738.9503
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 894.3662
fyv = 745.3052
εsuv = 0.032
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 = 1.00
εsuv = 0.4*εsuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: εsuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of εsuv_nominal and εyv, εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/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, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.7508007
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.38164216
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.67946571
and confined core properties:
b = 160.00
d = 347.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
εcc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.99259314
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.50454853
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.898285
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
' satisfies Eq. (4.4)
--->
v < εs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is not satisfied
--->
εcu (4.11) = 0.80138156
MRc (4.18) = 5.4612E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ω1, ω2, ωv normalised to bo*do, instead of b*d
- ε- parameters of confined concrete, fcc, εcc, used in lieu of fc, εcu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied

--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
$v^* < v^*_{c,y2}$ - LHS eq.(4.6) is not satisfied
--->
$v^* < v^*_{c,y1}$ - RHS eq.(4.6) is not satisfied
--->
 *cu (4.11) = 0.80674817
MRo (4.18) = 2.8580E+008
MRo < 0.8*MRc
--->
 u = cu (unconfined full section) = 3.1475172E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 339150.739

Calculation of Shear Strength at edge 1, Vr1 = 339150.739
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 339150.739
  knl = 1 (zero step-static loading)

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

    = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
     Mu = 6.7415E+007
     Vu = 3.6347847E-006
  d = 0.8*h = 320.00
  Nu = 1.8026E+006
  Ag = 80000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 471238.898
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 471238.898
  Vs,j1 = 157079.633 is calculated for section web jacket, with:
     d = 160.00
     Av = 157079.633
     fy = 625.00
     s = 100.00
  Vs,j1 is multiplied by   Col,j1 = 1.00
     s/d = 0.625
  Vs,j2 = 314159.265 is calculated for section flange jacket, with:
     d = 320.00
     Av = 157079.633
     fy = 625.00
     s = 100.00
  Vs,j2 is multiplied by   Col,j2 = 1.00
     s/d = 0.3125
  Vs,core = Vs,c1 + Vs,c2 = 0.00
  Vs,c1 = 0.00 is calculated for section web core, with:
     d = 80.00
     Av = 100530.965
     fy = 500.00
     s = 250.00
  Vs,c1 is multiplied by   Col,c1 = 0.00

```
    s/d = 3.125
  Vs,c2 = 0.00 is calculated for section flange core, with:
    d = 240.00
    Av = 100530.965
    fy = 500.00
    s = 250.00
  Vs,c2 is multiplied by   Col,c2 = 0.00
    s/d = 1.04167
  Vf ((11-3)-(11.4), ACI 440) = 0.00
  From (11-11), ACI 440: Vs + Vf <= 212577.225
    bw = 200.00
-----------------------------------------------------------------
------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 339150.739
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 339150.739
  knl = 1 (zero step-static loading)
-----------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+  f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
-----------------------------------------------------------------
    = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
    Mu = 5.3429E+007
    Vu = 3.6347847E-006
  d = 0.8*h = 320.00
  Nu = 1.8026E+006
  Ag = 80000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 471238.898
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 471238.898
  Vs,j1 = 157079.633 is calculated for section web jacket, with:
    d = 160.00
    Av = 157079.633
    fy = 625.00
    s = 100.00
  Vs,j1 is multiplied by   Col,j1 = 1.00
    s/d = 0.625
  Vs,j2 = 314159.265 is calculated for section flange jacket, with:
    d = 320.00
    Av = 157079.633
    fy = 625.00
    s = 100.00
  Vs,j2 is multiplied by   Col,j2 = 1.00
    s/d = 0.3125
  Vs,core = Vs,c1 + Vs,c2 = 0.00
  Vs,c1 = 0.00 is calculated for section web core, with:
    d = 80.00
    Av = 100530.965
    fy = 500.00
    s = 250.00
  Vs,c1 is multiplied by   Col,c1 = 0.00
    s/d = 3.125
  Vs,c2 = 0.00 is calculated for section flange core, with:
    d = 240.00
    Av = 100530.965
    fy = 500.00
    s = 250.00
  Vs,c2 is multiplied by   Col,c2 = 0.00
    s/d = 1.04167
  Vf ((11-3)-(11.4), ACI 440) = 0.00
  From (11-11), ACI 440: Vs + Vf <= 212577.225
    bw = 200.00
-----------------------------------------------------------------
-----------------------------------------------------------------
```

End Of Calculation of Shear Capacity ratio for element: column JLC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column JLC1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rcjlcs

Constant Properties

Knowledge Factor,   = 0.90
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 30.00
New material of Secondary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 18.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 500.00
Concrete Elasticity, Ec = 19940.411
Steel Elasticity, Es = 200000.00
Max Height, Hmax = 400.00
Min Height, Hmin = 200.00
Max Width, Wmax = 400.00
Min Width, Wmin = 200.00
Jacket Thickness, tj = 50.00
Cover Thickness, c = 15.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lb/ld>=1)
No FRP Wrapping

Stepwise Properties

Bending Moment, M = -7.2803E+007
Shear Force, V2 = 97644.268
Shear Force, V3 = 30.34672
Axial Force, F = -1.8003E+006
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 5353.274
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1137.257
     -Compression: Asl,com = 2208.54
        -Middle: Asl,mid = 2007.478
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,jacket = 829.3805
     -Compression: Asl,com,jacket = 1746.726
        -Middle: Asl,mid,jacket = 1545.664
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,core = 307.8761
     -Compression: Asl,com,core = 461.8141
        -Middle: Asl,mid,core = 461.8141
Mean Diameter of Tension Reinforcement, DbL = 16.80

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity u,R = * u = 0.00472303
  u = y + p = 0.00524781

 - Calculation of y -
----
 y = (My*Ls/3)/EIeff = 0.00524781 ((4.29),Biskinis Phd))
  My = 5.2685E+008
  Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 745.5987
  From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 2.4951E+013
     factor = 0.70
        Ag = 120000.00
        Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00
        N = 1.8003E+006
     Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.5645E+013

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7 -

Assuming neutral axis within flange (y < t/d, compression zone rectangular) with:
flange width, b = 400.00
web width, bw = 200.00
flange thickness, t = 200.00
----
  y = Min(y_ten, y_com)
  y_ten = 1.4407218E-005
 with fy = 596.2441
     d = 367.00
      y = 0.43617034
     A = 0.05703506
     B = 0.03712065
      with pt = 0.00774698
         pc = 0.01504455
         pv = 0.01367492
         N = 1.8003E+006
         b = 400.00
         " = 0.08991826
  y_comp = 1.2588515E-005
 with fc = 30.00
     Ec = 25742.96
      y = 0.45404063
     A = 0.00723408
     B = 0.01655203
      with Es = 200000.00
CONFIRMATION: y = 0.45404063 < t/d

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

 - 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/VColOE = 1.18753
   d = d_external = 367.00
   s = s_external = 100.00
 - t = s1 + s2 + 2*tf/bw*(ffe/fs) = 0.00809358
   jacket: s1 = Av1*Lstir1/(s1*Ag) = 0.00680678

Av1 = 78.53982, is the area of every stirrup parallel to loading (shear) direction
Lstir1 = 1040.00, is the total Length of all stirrups parallel to loading (shear) direction
s1 = 100.00

core: s2 = Av2*Lstir2/(s2*Ag) = 0.0012868
Av2 = 50.26548, is the area of every stirrup parallel to loading (shear) direction
Lstir2 = 768.00, is the total Length of all stirrups parallel to loading (shear) direction
s2 = 250.00

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.

For the normalisation fs of jacket is used.

NUD = 1.8003E+006

Ag = 120000.00

f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 25.00

fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein = 596.2441

fytE = (fy_ext_Trans_Reinf* s1+fy_int_Trans_Reinf* s2)/(s1+ s2) = 605.1263

pl = Area_Tot_Long_Rein/(b*d) = 0.03646644

b = 400.00

d = 367.00

f'cE = 25.00

End Of Calculation of Chord Rotation Capacity for element: column JLC1 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 50 and 51)

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (2)

Start Of Calculation of Shear Capacity for element: column JLC1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rcjlcs

Constant Properties

Knowledge Factor, = 0.90
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 12.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 19940.411
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, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 30.00
New material: Steel Strength, fs = fsm = 625.00
Existing Column
Existing material: Concrete Strength, fc = fcm = 18.00
Existing material: Steel Strength, fs = fsm = 500.00
##
Max Height, Hmax = 400.00
Min Height, Hmin = 200.00
Max Width, Wmax = 400.00
Min Width, Wmin = 200.00
Jacket Thickness, tj = 50.00
Cover Thickness, c = 15.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min = lb/ld >=1)
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -3.0601E+008
Shear Force, Va = -62256.122
EDGE -B-
Bending Moment, Mb = -6.5602E+007
Shear Force, Vb = 62256.122
BOTH EDGES
Axial Force, F = -1.8013E+006
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 2161.416
    -Compression: Aslc = 3191.858
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 2208.54
    -Compression: Asl,com = 1137.257
        -Middle: Asl,mid = 2007.478

Mean Diameter of Tension Reinforcement, DbL,ten = 16.60

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR =   *Vn = 258166.022
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 286851.135
   VCol = 286851.135
   knl = 1.00
      displacement_ductility_demand = 1.66929

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

     = 1 (normal-weight concrete)
   Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 16.66667, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
   M/Vd = 4.00
      Mu = 3.0601E+008
      Vu = 62256.122
   d = 0.8*h = 320.00
   Nu = 1.8013E+006
   Ag = 80000.00
   From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 376991.118
   where:
   Vs,jacket = Vs,j1 + Vs,j2 = 376991.118
   Vs,j1 = 125663.706 is calculated for section web jacket, with:
      d = 160.00
      Av = 157079.633
      fy = 500.00
      s = 100.00
   Vs,j1 is multiplied by   Col,j1 = 1.00
      s/d = 0.625
   Vs,j2 = 251327.412 is calculated for section flange jacket, with:
      d = 320.00
      Av = 157079.633
      fy = 500.00
      s = 100.00
   Vs,j2 is multiplied by   Col,j2 = 1.00
      s/d = 0.3125
   Vs,core = Vs,c1 + Vs,c2 = 0.00
   Vs,c1 = 0.00 is calculated for section web core, with:
      d = 80.00
      Av = 100530.965
      fy = 400.00
      s = 250.00
   Vs,c1 is multiplied by   Col,c1 = 0.00
      s/d = 3.125
   Vs,c2 = 0.00 is calculated for section flange core, with:
      d = 240.00
      Av = 100530.965
      fy = 400.00
      s = 250.00
   Vs,c2 is multiplied by   Col,c2 = 0.00
      s/d = 1.04167
   Vf ((11-3)-(11.4), ACI 440) = 0.00
   From (11-11), ACI 440: Vs + Vf <= 173568.578
      bw = 200.00

----
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   = 0.03426582

y = (My*Ls/3)/EIeff = 0.02052718 ((4.29),Biskinis Phd))
  My = 3.1260E+008
  Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 4915.337
  From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 2.4951E+013
     factor = 0.70
        Ag = 120000.00
        Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00
        N = 1.8013E+006
     Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.5645E+013

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7 -
----
 y = Min(y_ten, y_com)
 y_ten = 1.9273633E-005
with fy = 596.2441
    d = 367.00
     y = 0.57853212
    A = 0.11409279
    B = 0.08754673
     with pt = 0.0300891
        pc = 0.01549396
        pv = 0.02734983
        N = 1.8013E+006
        b = 200.00
        " = 0.08991826
  y_comp = 7.6802956E-006
with fc = 30.00
    Ec = 25742.96
     y = 0.74420275
    A = 0.01443594
    B = 0.04638683
     with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

End Of Calculation of Shear Capacity for element: column JLC1 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 50 and 51)

Analysis: Uniform + X

Check: Chord rotation capacity (u)

Edge: Start

Local Axis: (2)

Start Of Calculation of Shear Capacity ratio for element: column JLC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcjlcs

Constant Properties

Knowledge Factor, = 0.90
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 30.00
New material of Secondary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 18.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 500.00
Concrete Elasticity, Ec = 19940.411
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
Jacket
New material: Steel Strength, fs = 1.25*fsm = 781.25
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 625.00
##
Max Height, Hmax = 400.00
Min Height, Hmin = 200.00
Max Width, Wmax = 400.00
Min Width, Wmin = 200.00
Jacket Thickness, tj = 50.00
Cover Thickness, c = 15.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = 2.3476251E-006
EDGE -B-
Shear Force, Vb = -2.3476251E-006
BOTH EDGES
Axial Force, F = -1.8026E+006
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 5353.274
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 2208.54
     -Compression: Asl,com = 1137.257
         -Middle: Asl,mid = 2007.478

Calculation of Shear Capacity ratio , Ve/Vr = 1.44151
Member Controlled by Shear (Ve/Vr > 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 488890.189
with
Mpr1 = Max(Mu1+ , Mu1-) = 7.3334E+008
   Mu1+ = 7.3334E+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- = 6.3768E+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-) = 7.3334E+008
   Mu2+ = 7.3334E+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- = 6.3768E+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 = 4.2207094E-005
Mu = 7.3334E+008
----
with full section properties:
  b = 400.00
  d = 367.00
  d' = 33.00
  v = 0.40931126
    N = 1.8026E+006
  fc = 30.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00925707
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: cu = 0.00925707
       we (5.4c) = 0.0207149
        ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.33836562
          ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
          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)

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"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max1 = 89600.00 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 external perimeter hoops.
Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max1 by a length
equal to half the clear spacing between external hoops.
AnoConf1 = 43733.333 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
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,max2 = 45264.00 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 internal perimeter hoops.
Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 32309.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205

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

----

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
Lstir1 (Length of stirrups along Y) = 1040.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
Lstir2 (Length of stirrups along Y) = 768.00
Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
Lstir1 (Length of stirrups along X) = 1040.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
Lstir2 (Length of stirrups along X) = 768.00
Astir2 (stirrups area) = 50.26548

Asec = 120000.00
s1 = 100.00
s2 = 250.00
fywe1 = 781.25
fywe2 = 625.00
fce = 30.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.0025
sh1 = 0.008
ft1 = 898.293
fy1 = 748.5775
su1 = 0.032
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 = 1.00
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, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 748.5775
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 886.7403

fy2 = 738.9503
     su2 = 0.032
       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 = 1.00
         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, ASCE 41-17.
         with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 738.9503
         with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
     yv = 0.0025
     shv = 0.008
   ftv = 894.3662
   fyv = 745.3052
     suv = 0.032
       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 = 1.00
         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, ASCE 41-17.
         with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
         with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.37540035
     2 = Asl,com/(b*d)*(fs2/fc) = 0.19082108
     v = Asl,mid/(b*d)*(fsv/fc) = 0.33973286
and confined core properties:
   b = 360.00
   d = 347.00
   d' = 13.00
   fcc (5A.2, TBDY) = 30.00
     cc (5A.5, TBDY) = 0.002
       c = confinement factor = 1.00
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.44115251
     2 = Asl,com/(b*d)*(fs2/fc) = 0.22424379
     v = Asl,mid/(b*d)*(fsv/fc) = 0.39923778
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
  ' satisfies Eq. (4.4)
--->
v <   s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
  cu (4.10) = 0.59761571
MRc (4.17) = 7.3334E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
   - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
   - N, 1,   2,   v normalised to bo*do, instead of b*d
   - - parameters of confined concrete, fcc, cc, used in lieu of fc, ecu

--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 *cu (4.11) = 0.62879536
MRo (4.18) = 4.5866E+008
MRo < 0.8*MRc
--->
 u = cu (unconfined full section) = 4.2207094E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 u = 4.8346386E-005
Mu = 6.3768E+008
----
with full section properties:
 b = 200.00
 d = 367.00
 d' = 33.00
 v = 0.81862252
   N = 1.8026E+006
 fc = 30.00
  co (5A.5, TBDY) = 0.002
 Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00925707
   The Shear_factor is considered equal to 1 (pure moment strength)
   From (5.4b), TBDY: cu = 0.00925707
     we (5.4c) = 0.0207149
     ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.33836562
       ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
       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,max1 = 89600.00 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 external perimeter hoops.
       Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
              is calculated by reducing all the dimensions of the area Aconf,max1 by a length
              equal to half the clear spacing between external hoops.
       AnoConf1 = 43733.333 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
     ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
       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,max2 = 45264.00 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 internal perimeter hoops.
Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
    is calculated by reducing all the dimensions of the area Aconf,max2 by a length
    equal to half the clear spacing between internal hoops.
AnoConf2 = 32309.333 is the unconfined internal core area which is equal to $bi2/6$ as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
  Lstir1 (Length of stirrups along Y) = 1040.00
  Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
  Lstir2 (Length of stirrups along Y) = 768.00
  Astir2 (stirrups area) = 50.26548

----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
  Lstir1 (Length of stirrups along X) = 1040.00
  Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
  Lstir2 (Length of stirrups along X) = 768.00
  Astir2 (stirrups area) = 50.26548

Asec = 120000.00
s1 = 100.00
s2 = 250.00
fywe1 = 781.25
fywe2 = 625.00
fce = 30.00
From ((5.A5), TBDY), TBDY: cc = 0.002
  c = confinement factor = 1.00
y1 = 0.0025
sh1 = 0.008
ft1 = 886.7403
fy1 = 738.9503
su1 = 0.032
  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 = 1.00
  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, ASCE 41-17.
  with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 738.9503
  with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 898.293
fy2 = 748.5775
su2 = 0.032
  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 = 1.00
  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, ASCE 41-17.
  with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 748.5775
  with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.0025
shv = 0.008
ftv = 894.3662
fyv = 745.3052
suv = 0.032
  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 = 1.00
   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, ASCE 41-17.
   with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
   with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.38164216
  2 = Asl,com/(b*d)*(fs2/fc) = 0.7508007
  v = Asl,mid/(b*d)*(fsv/fc) = 0.67946571
and confined core properties:
  b = 160.00
  d = 347.00
  d' = 13.00
  fcc (5A.2, TBDY) = 30.00
   cc (5A.5, TBDY) = 0.002
     c = confinement factor = 1.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.50454853
   2 = Asl,com/(b*d)*(fs2/fc) = 0.99259314
   v = Asl,mid/(b*d)*(fsv/fc) = 0.898285
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
 ' satisfies Eq. (4.4)
--->
v < s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
 cu (4.10) = 0.52172715
MRc (4.17) = 6.3768E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N, 1, 2, v normalised to bo*do, instead of b*d
  - - parameters of confined concrete, fcc, cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->

v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 *cu (4.11) = 0.5604845
MRo (4.18) = 4.7738E+008
MRo < 0.8*MRc
--->
 u =   cu (unconfined full section) = 4.8346386E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 4.2207094E-005
Mu = 7.3334E+008
----
with full section properties:
  b = 400.00
  d = 367.00
  d' = 33.00
  v = 0.40931126
    N = 1.8026E+006
  fc = 30.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00925707
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00925707
      we (5.4c) = 0.0207149
      ase ((5.4d), TBDY) = (ase1*Aext+ ase2*Aint)/Asec = 0.33836562
        ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
        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,max1 = 89600.00 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 external perimeter hoops.
        Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
                is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                equal to half the clear spacing between external hoops.
        AnoConf1 = 43733.333 is the unconfined external core area which is equal to   bi2/6 as defined at (A.2).
      ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
        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,max2 = 45264.00 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 internal perimeter hoops.
        Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
                is calculated by reducing all the dimensions of the area Aconf,max2 by a length
                equal to half the clear spacing between internal hoops.
        AnoConf2 = 32309.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
      psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
    Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
        ----
        psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678

$\qquad$ Lstir1 (Length of stirrups along Y) = 1040.00
$\qquad$ Astir1 (stirrups area) = 78.53982
$\qquad$ psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
$\qquad$ Lstir2 (Length of stirrups along Y) = 768.00
$\qquad$ Astir2 (stirrups area) = 50.26548

$\qquad$ psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
$\qquad$ psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
$\qquad$ Lstir1 (Length of stirrups along X) = 1040.00
$\qquad$ Astir1 (stirrups area) = 78.53982
$\qquad$ psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
$\qquad$ Lstir2 (Length of stirrups along X) = 768.00
$\qquad$ Astir2 (stirrups area) = 50.26548

$\qquad$ Asec = 120000.00
$\qquad$ s1 = 100.00
$\qquad$ s2 = 250.00
$\qquad$ fywe1 = 781.25
$\qquad$ fywe2 = 625.00
$\qquad$ fce = 30.00
From ((5.A5), TBDY): cc = 0.002
$\qquad$ c = confinement factor = 1.00
y1 = 0.0025
sh1 = 0.008
ft1 = 898.293
fy1 = 748.5775
su1 = 0.032
$\quad$ using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
$\quad$ and also multiplied by the shear_factor according to 15.7.1.4, with
$\quad$ Shear_factor = 1.00
$\quad$ lo/lou,min = lb/ld = 1.00
$\quad$ su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
$\quad$ From table 5A.1, TBDY: esu1_nominal = 0.08,
$\quad$ For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
$\quad$ characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
$\quad$ y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
$\quad$ with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 748.5775
$\quad$ with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 886.7403
fy2 = 738.9503
su2 = 0.032
$\quad$ using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
$\quad$ and also multiplied by the shear_factor according to 15.7.1.4, with
$\quad$ Shear_factor = 1.00
$\quad$ lo/lou,min = lb/lb,min = 1.00
$\quad$ su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
$\quad$ From table 5A.1, TBDY: esu2_nominal = 0.08,
$\quad$ For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
$\quad$ characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
$\quad$ y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
$\quad$ with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 738.9503
$\quad$ with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 894.3662
fyv = 745.3052
suv = 0.032
$\quad$ using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
$\quad$ and also multiplied by the shear_factor according to 15.7.1.4, with
$\quad$ Shear_factor = 1.00
$\quad$ lo/lou,min = lb/ld = 1.00
$\quad$ suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
$\quad$ From table 5A.1, TBDY: esuv_nominal = 0.08,
$\quad$ considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
$\quad$ 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, ASCE 41-17.
   with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
   with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.37540035
  2 = Asl,com/(b*d)*(fs2/fc) = 0.19082108
  v = Asl,mid/(b*d)*(fsv/fc) = 0.33973286
and confined core properties:
  b = 360.00
  d = 347.00
  d' = 13.00
  fcc (5A.2, TBDY) = 30.00
   cc (5A.5, TBDY) = 0.002
      c = confinement factor = 1.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.44115251
  2 = Asl,com/(b*d)*(fs2/fc) = 0.22424379
  v = Asl,mid/(b*d)*(fsv/fc) = 0.39923778
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
  ' satisfies Eq. (4.4)
--->
v <   s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
 cu (4.10) = 0.59761571
MRc (4.17) = 7.3334E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N, 1, 2, v normalised to bo*do, instead of b*d
  - -   parameters of confined concrete, fcc, cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 *cu (4.11) = 0.62879536
MRo (4.18) = 4.5866E+008
MRo < 0.8*MRc
--->
 u =   cu (unconfined full section) = 4.2207094E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 4.8346386E-005
Mu = 6.3768E+008
----
with full section properties:
  b = 200.00
  d = 367.00
  d' = 33.00
  ν = 0.81862252
    N = 1.8026E+006
  fc = 30.00
   εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.00925707
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: εcu = 0.00925707
       ωwe (5.4c) = 0.0207149
       αse ((5.4d), TBDY) = (αse1*Aext+αse2*Aint)/Asec = 0.33836562
         αse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
         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,max1 = 89600.00 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 external perimeter hoops.
         Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
                 is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                 equal to half the clear spacing between external hoops.
         AnoConf1 = 43733.333 is the unconfined external core area which is equal to Σbi2/6 as defined at (A.2).
       αse2 (>=αse1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
         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,max2 = 45264.00 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 internal perimeter hoops.
         Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
                 is calculated by reducing all the dimensions of the area Aconf,max2 by a length
                 equal to half the clear spacing between internal hoops.
         AnoConf2 = 32309.333 is the unconfined internal core area which is equal to Σbi2/6 as defined at (A.2).
       ρsh,min*Fywe = Min(ρsh,x*Fywe , ρsh,y*Fywe) = 6.12205
     Expression (5.4d) for ρsh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

       ρsh_x*Fywe = ρsh1*Fywe1+ρs2*Fywe2 = 6.12205
       ρsh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
         Lstir1 (Length of stirrups along Y) = 1040.00
         Astir1 (stirrups area) = 78.53982
       ρsh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
         Lstir2 (Length of stirrups along Y) = 768.00
         Astir2 (stirrups area) = 50.26548

       ρsh_y*Fywe = ρsh1*Fywe1+ρs2*Fywe2 = 6.12205
       ρsh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
         Lstir1 (Length of stirrups along X) = 1040.00
         Astir1 (stirrups area) = 78.53982
       ρsh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
         Lstir2 (Length of stirrups along X) = 768.00
         Astir2 (stirrups area) = 50.26548

```
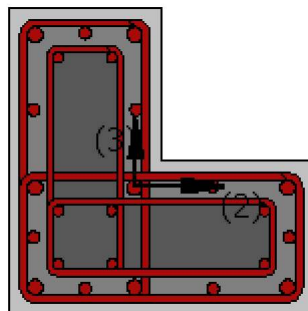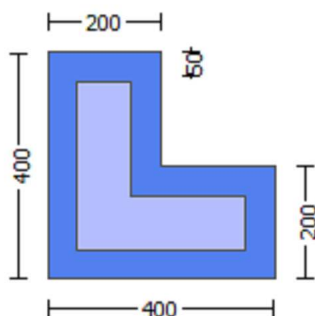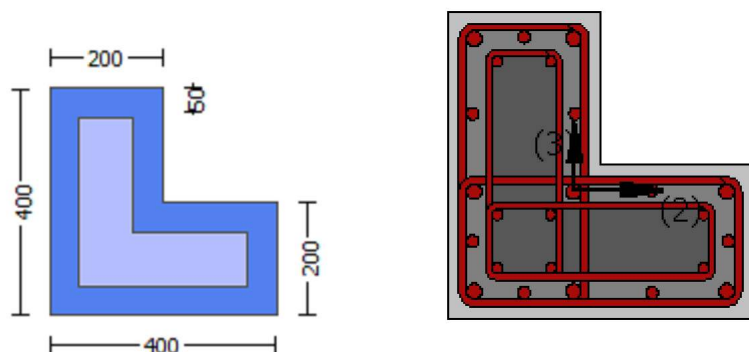---------------------------------------------------------------------
         Asec = 120000.00
           s1 = 100.00
           s2 = 250.00
        fywe1 = 781.25
        fywe2 = 625.00
         fce  = 30.00
    From ((5.A5), TBDY),  TBDY:   cc = 0.002
         c  = confinement factor = 1.00
   y1 = 0.0025
  sh1 = 0.008
 ft1 = 886.7403
 fy1 = 738.9503
  su1 = 0.032
    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 = 1.00
     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, ASCE 41-17.
      with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 738.9503
      with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
   y2 = 0.0025
  sh2 = 0.008
 ft2 = 898.293
 fy2 = 748.5775
  su2 = 0.032
    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 = 1.00
     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, ASCE 41-17.
      with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 748.5775
      with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
   yv = 0.0025
  shv = 0.008
 ftv = 894.3662
 fyv = 745.3052
  suv = 0.032
    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 = 1.00
     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, ASCE 41-17.
      with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
      with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.38164216
    2 = Asl,com/(b*d)*(fs2/fc) = 0.7508007
    v = Asl,mid/(b*d)*(fsv/fc) = 0.67946571
and confined core properties:
  b = 160.00
  d = 347.00
  d' = 13.00
  fcc (5A.2, TBDY) = 30.00
   cc (5A.5, TBDY) = 0.002
```

c = confinement factor = 1.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.50454853

2 = Asl,com/(b*d)*(fs2/fc) = 0.99259314

v = Asl,mid/(b*d)*(fsv/fc) = 0.898285

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 not satisfied

--->

Case/Assumption Rejected.

--->

New Case/Assumption: Unconfinesd full section - Spalling of concrete cover

' satisfies Eq. (4.4)

--->

v < s,y1 - LHS eq.(4.7) is not satisfied

--->

v < vc,y1 - RHS eq.(4.6) is satisfied

--->

cu (4.10) = 0.52172715

MRc (4.17) = 6.3768E+008

--->

New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover

In expressions below, the following modifications have been made

- b, d, d' replaced by geometric parameters of the core: bo, do, d'o

- N, 1, 2, v normalised to bo*do, instead of b*d

- - parameters of confined concrete, fcc, cc, used in lieu of fc, ecu

--->

Subcase: Rupture of tension steel

--->

v* < v*s,y2 - LHS eq.(4.5) is not satisfied

--->

v* < v*s,c - LHS eq.(4.5) is not satisfied

--->

Subcase rejected

--->

New Subcase: Failure of compression zone

--->

v* < v*c,y2 - LHS eq.(4.6) is not satisfied

--->

v* < v*c,y1 - RHS eq.(4.6) is not satisfied

--->

*cu (4.11) = 0.5604845

MRo (4.18) = 4.7738E+008

MRo < 0.8*MRc

--->

u = cu (unconfined full section) = 4.8346386E-005

Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 339150.739

Calculation of Shear Strength at edge 1, Vr1 = 339150.739

Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0

VCol0 = 339150.739

knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ f*Vf'

where Vf is the contribution of FRPs (11.3), ACI 440).

```
-------------------------------------------------------------
     = 1 (normal-weight concrete)
   Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
    M/Vd = 4.00
      Mu = 2.0345E+006
      Vu = 2.3476251E-006
    d = 0.8*h = 320.00
    Nu = 1.8026E+006
    Ag = 80000.00
    From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 471238.898
    where:
   Vs,jacket = Vs,j1 + Vs,j2 = 471238.898
   Vs,j1 = 314159.265 is calculated for section web jacket, with:
      d = 320.00
      Av = 157079.633
      fy = 625.00
      s = 100.00
   Vs,j1 is multiplied by   Col,j1 = 1.00
      s/d = 0.3125
   Vs,j2 = 157079.633 is calculated for section flange jacket, with:
      d = 160.00
      Av = 157079.633
      fy = 625.00
      s = 100.00
   Vs,j2 is multiplied by   Col,j2 = 1.00
      s/d = 0.625
   Vs,core = Vs,c1 + Vs,c2 = 0.00
   Vs,c1 = 0.00 is calculated for section web core, with:
      d = 240.00
      Av = 100530.965
      fy = 500.00
      s = 250.00
   Vs,c1 is multiplied by   Col,c1 = 0.00
      s/d = 1.04167
   Vs,c2 = 0.00 is calculated for section flange core, with:
      d = 80.00
      Av = 100530.965
      fy = 500.00
      s = 250.00
   Vs,c2 is multiplied by   Col,c2 = 0.00
      s/d = 3.125
   Vf ((11-3)-(11.4), ACI 440) = 0.00
   From (11-11), ACI 440: Vs + Vf <= 212577.225
      bw = 200.00
-----------------------------------------------------------
-------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 339150.739
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
   VCol0 = 339150.739
   knl = 1 (zero step-static loading)
-----------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+  f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
-----------------------------------------------------------
     = 1 (normal-weight concrete)
   Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
    M/Vd = 4.00
      Mu = 6739.685
      Vu = 2.3476251E-006
    d = 0.8*h = 320.00
    Nu = 1.8026E+006
    Ag = 80000.00
    From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 471238.898
    where:
   Vs,jacket = Vs,j1 + Vs,j2 = 471238.898
```

Vs,j1 = 314159.265 is calculated for section web jacket, with:
    d = 320.00
    Av = 157079.633
    fy = 625.00
    s = 100.00
Vs,j1 is multiplied by Col,j1 = 1.00
    s/d = 0.3125
Vs,j2 = 157079.633 is calculated for section flange jacket, with:
    d = 160.00
    Av = 157079.633
    fy = 625.00
    s = 100.00
Vs,j2 is multiplied by Col,j2 = 1.00
    s/d = 0.625
Vs,core = Vs,c1 + Vs,c2 = 0.00
Vs,c1 = 0.00 is calculated for section web core, with:
    d = 240.00
    Av = 100530.965
    fy = 500.00
    s = 250.00
Vs,c1 is multiplied by Col,c1 = 0.00
    s/d = 1.04167
Vs,c2 = 0.00 is calculated for section flange core, with:
    d = 80.00
    Av = 100530.965
    fy = 500.00
    s = 250.00
Vs,c2 is multiplied by Col,c2 = 0.00
    s/d = 3.125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 212577.225
    bw = 200.00

End Of Calculation of Shear Capacity ratio for element: column JLC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column JLC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjlcs

Constant Properties

Knowledge Factor,   = 0.90
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 30.00
New material of Secondary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 18.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 500.00
Concrete Elasticity, Ec = 19940.411
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
Jacket
New material: Steel Strength, fs = 1.25*fsm = 781.25
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 625.00

```
#############################################################
Max Height, Hmax = 400.00
Min Height, Hmin = 200.00
Max Width, Wmax = 400.00
Min Width, Wmin = 200.00
Jacket Thickness, tj = 50.00
Cover Thickness, c = 15.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping
-------------------------------------------------------------

Stepwise Properties
-------------------------------------------------------------
At local axis: 2
EDGE -A-
Shear Force, Va = -3.6347847E-006
EDGE -B-
Shear Force, Vb = 3.6347847E-006
BOTH EDGES
Axial Force, F = -1.8026E+006
Longitudinal Reinforcement Area Distribution (in 2 divisions)
       -Tension: Aslt = 0.00
    -Compression: Aslc = 5353.274
Longitudinal Reinforcement Area Distribution (in 3 divisions)
       -Tension: Asl,ten = 1137.257
    -Compression: Asl,com = 2208.54
        -Middle: Asl,mid = 2007.478
-------------------------------------------------------------
-------------------------------------------------------------
```

Calculation of Shear Capacity ratio , Ve/Vr = 1.18753
Member Controlled by Shear (Ve/Vr > 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 402750.026
with
Mpr1 = Max(Mu1+ , Mu1-) = 6.0413E+008
   Mu1+ = 6.0413E+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- = 5.4612E+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-) = 6.0413E+008
   Mu2+ = 6.0413E+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- = 5.4612E+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 = 1.2613948E-005
Mu = 6.0413E+008
----
with full section properties:
  b = 400.00
  d = 367.00
  d' = 33.00
  v = 0.40931126

N = 1.8026E+006
  fc = 30.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00925707
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: cu = 0.00925707
       we (5.4c) = 0.0207149
        ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.33836562
           ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
           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,max1 = 89600.00 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 external perimeter hoops.
           Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
                   is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                   equal to half the clear spacing between external hoops.
           AnoConf1 = 43733.333 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
         ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
           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,max2 = 45264.00 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 internal perimeter hoops.
           Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
                   is calculated by reducing all the dimensions of the area Aconf,max2 by a length
                   equal to half the clear spacing between internal hoops.
           AnoConf2 = 32309.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
        psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
     Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
  earthquake detailing (90° closed stirrups)
       ----
       psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
       psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
          Lstir1 (Length of stirrups along Y) = 1040.00
          Astir1 (stirrups area) = 78.53982
       psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
          Lstir2 (Length of stirrups along Y) = 768.00
          Astir2 (stirrups area) = 50.26548
       ----
       psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
       psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
          Lstir1 (Length of stirrups along X) = 1040.00
          Astir1 (stirrups area) = 78.53982
       psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
          Lstir2 (Length of stirrups along X) = 768.00
          Astir2 (stirrups area) = 50.26548

          Asec = 120000.00
          s1 = 100.00
          s2 = 250.00
        fywe1 = 781.25
        fywe2 = 625.00
        fce = 30.00
     From ((5.A5), TBDY), TBDY: cc = 0.002
         c = confinement factor = 1.00
    y1 = 0.0025
   sh1 = 0.008
  ft1 = 886.7403
  fy1 = 738.9503
   su1 = 0.032
     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 = 1.00
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, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 738.9503
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 898.293
fy2 = 748.5775
su2 = 0.032
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 = 1.00
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, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 748.5775
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 894.3662
fyv = 745.3052
suv = 0.032
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 = 1.00
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, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.19082108
2 = Asl,com/(b*d)*(fs2/fc) = 0.37540035
v = Asl,mid/(b*d)*(fsv/fc) = 0.33973286
and confined core properties:
b = 360.00
d = 347.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.22424379
2 = Asl,com/(b*d)*(fs2/fc) = 0.44115251
v = Asl,mid/(b*d)*(fsv/fc) = 0.39923778
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
' satisfies Eq. (4.4)
--->

v <   s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
 cu (4.10) = 0.37716748
MRc (4.17) = 7.0585E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N,   1,   2,   v normalised to bo*do, instead of b*d
  - - parameters of confined concrete, fcc, cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 *cu (4.11) = 0.4569298
MRo (4.18) = 6.0413E+008
--->
 u =   cu (4.2) = 1.2613948E-005
Mu = MRo

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
 u = 3.1475172E-005
Mu = 5.4612E+008
----
with full section properties:
  b = 200.00
  d = 367.00
  d' = 33.00
  v = 0.81862252
    N = 1.8026E+006
  fc = 30.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00925707
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00925707
      we (5.4c) = 0.0207149
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.33836562
        ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
        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,max1 = 89600.00 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 external perimeter hoops.
Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
    is calculated by reducing all the dimensions of the area Aconf,max1 by a length
    equal to half the clear spacing between external hoops.
AnoConf1 = 43733.333 is the unconfined external core area which is equal to   bi2/6 as defined at (A.2).
ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
    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,max2 = 45264.00 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 internal perimeter hoops.
Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
    is calculated by reducing all the dimensions of the area Aconf,max2 by a length
    equal to half the clear spacing between internal hoops.
AnoConf2 = 32309.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
    ----
    psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
    psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
        Lstir1 (Length of stirrups along Y) = 1040.00
        Astir1 (stirrups area) = 78.53982
    psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
        Lstir2 (Length of stirrups along Y) = 768.00
        Astir2 (stirrups area) = 50.26548
    ----
    psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
    psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
        Lstir1 (Length of stirrups along X) = 1040.00
        Astir1 (stirrups area) = 78.53982
    psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
        Lstir2 (Length of stirrups along X) = 768.00
        Astir2 (stirrups area) = 50.26548

    Asec = 120000.00
    s1 = 100.00
    s2 = 250.00
    fywe1 = 781.25
    fywe2 = 625.00
    fce = 30.00
From ((5.A5), TBDY, TBDY: cc = 0.002
    c = confinement factor = 1.00
y1 = 0.0025
sh1 = 0.008
ft1 = 898.293
fy1 = 748.5775
su1 = 0.032
    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 = 1.00
    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, ASCE 41-17.
    with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 748.5775
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 886.7403
fy2 = 738.9503
su2 = 0.032

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 = 1.00
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, 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, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 738.9503
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.0025
εshv = 0.008
ftv = 894.3662
fyv = 745.3052
εsuv = 0.032
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 = 1.00
εsuv = 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, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.7508007
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.38164216
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.67946571
and confined core properties:
b = 160.00
d = 347.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
εcc (5A.5, TBDY) = 0.002
αc = confinement factor = 1.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.99259314
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.50454853
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.898285
Case/Assumption: Unconfinesd full section - Steel rupture
ε' satisfies Eq. (4.3)
--->
εv < εvs,y2 - LHS eq.(4.5) is not satisfied
--->
εv < εvs,c - RHS eq.(4.5) is not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
ε' satisfies Eq. (4.4)
--->
εv < εs,y1 - LHS eq.(4.7) is not satisfied
--->
εv < εvc,y1 - RHS eq.(4.6) is not satisfied
--->
φcu (4.11) = 0.80138156
MRc (4.18) = 5.4612E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
- b, d, d' replaced by geometric parameters of the core: bo, do, d'o
- N, ω1, ω2, ωv normalised to bo*do, instead of b*d
- ε - parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel

--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 *cu (4.11) = 0.80674817
MRo (4.18) = 2.8580E+008
MRo < 0.8*MRc
--->
 u =   cu (unconfined full section) = 3.1475172E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.2613948E-005
Mu = 6.0413E+008
----
with full section properties:
  b = 400.00
  d = 367.00
  d' = 33.00
  v = 0.40931126
    N = 1.8026E+006
  fc = 30.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00925707
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00925707
      we (5.4c) = 0.0207149
       ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.33836562
          ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
          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,max1 = 89600.00 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 external perimeter hoops.
          Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
                 is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                 equal to half the clear spacing between external hoops.
          AnoConf1 = 43733.333 is the unconfined external core area which is equal to   bi2/6 as defined at (A.2).
        ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
          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,max2 = 45264.00 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 internal perimeter hoops.
Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 32309.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
   Lstir1 (Length of stirrups along Y) = 1040.00
   Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
   Lstir2 (Length of stirrups along Y) = 768.00
   Astir2 (stirrups area) = 50.26548
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
   Lstir1 (Length of stirrups along X) = 1040.00
   Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
   Lstir2 (Length of stirrups along X) = 768.00
   Astir2 (stirrups area) = 50.26548

Asec = 120000.00
s1 = 100.00
s2 = 250.00
fywe1 = 781.25
fywe2 = 625.00
fce = 30.00
From ((5.A5), TBDY), TBDY: cc = 0.002
   c = confinement factor = 1.00
y1 = 0.0025
sh1 = 0.008
ft1 = 886.7403
fy1 = 738.9503
su1 = 0.032
   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 = 1.00
    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, ASCE 41-17.
    with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 738.9503
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 898.293
fy2 = 748.5775
su2 = 0.032
   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 = 1.00
    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, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 748.5775
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008

ftv = 894.3662
fyv = 745.3052
  suv = 0.032
    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 = 1.00
     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, ASCE 41-17.
     with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
     with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.19082108
   2 = Asl,com/(b*d)*(fs2/fc) = 0.37540035
   v = Asl,mid/(b*d)*(fsv/fc) = 0.33973286
and confined core properties:
  b = 360.00
  d = 347.00
  d' = 13.00
  fcc (5A.2, TBDY) = 30.00
   cc (5A.5, TBDY) = 0.002
      c = confinement factor = 1.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.22424379
   2 = Asl,com/(b*d)*(fs2/fc) = 0.44115251
   v = Asl,mid/(b*d)*(fsv/fc) = 0.39923778
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
  ' satisfies Eq. (4.4)
--->
v < s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
 cu (4.10) = 0.37716748
MRc (4.17) = 7.0585E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N, 1, 2, v normalised to bo*do, instead of b*d
  - - parameters of confined concrete, fcc, cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->

```
 εcu (4.11) = 0.4569298
MRo (4.18) = 6.0413E+008
--->
  φu =   εcu (4.2) = 1.2613948E-005
Mu = MRo
-----------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
-----------------------------------------------------------------------
-----------------------------------------------------------------------
-----------------------------------------------------------------------
Calculation of Mu2-
-----------------------------------------------------------------------

-----------------------------------------------------------------------
Calculation of ultimate curvature  φu according to 4.1, Biskinis/Fardis 2013:
  φu = 3.1475172E-005
Mu = 5.4612E+008
-----------------------------------------------------------------------
with full section properties:
  b = 200.00
  d = 367.00
  d' = 33.00
  v = 0.81862252
    N = 1.8026E+006
  fc = 30.00
   εco (5A.5, TBDY) = 0.002
  Final value of εcu:  εcu* = shear_factor * Max(εcu, εcc) = 0.00925707
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY:  εcu = 0.00925707
      αωe (5.4c) = 0.0207149
      αse ((5.4d), TBDY) = (αse1*Aext+αse2*Aint)/Asec = 0.33836562
         αse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
         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,max1 = 89600.00 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 external perimeter hoops.
         Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
                 is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                 equal to half the clear spacing between external hoops.
         AnoConf1 = 43733.333 is the unconfined external core area which is equal to  bi2/6 as defined at (A.2).
       αse2 (>=αse1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
         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,max2 = 45264.00 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 internal perimeter hoops.
         Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
                 is calculated by reducing all the dimensions of the area Aconf,max2 by a length
                 equal to half the clear spacing between internal hoops.
         AnoConf2 = 32309.333 is the unconfined internal core area which is equal to  bi2/6 as defined at (A.2).
       ρsh,min*Fywe = Min(ρsh,x*Fywe , ρsh,y*Fywe) = 6.12205
    Expression (5.4d) for ρsh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
      ------------------------------------------------------------------
        ρsh_x*Fywe = ρsh1*Fywe1+ρs2*Fywe2 = 6.12205
        ρsh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
           Lstir1 (Length of stirrups along Y) = 1040.00
           Astir1 (stirrups area) = 78.53982
        ρsh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
```

Lstir2 (Length of stirrups along Y) = 768.00
         Astir2 (stirrups area) = 50.26548
    ----
     psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
     psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
         Lstir1 (Length of stirrups along X) = 1040.00
         Astir1 (stirrups area) = 78.53982
     psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
         Lstir2 (Length of stirrups along X) = 768.00
         Astir2 (stirrups area) = 50.26548

         Asec = 120000.00
         s1 = 100.00
         s2 = 250.00
       fywe1 = 781.25
       fywe2 = 625.00
       fce = 30.00
   From ((5.A5), TBDY), TBDY: cc = 0.002
         c = confinement factor = 1.00
  y1 = 0.0025
  sh1 = 0.008
 ft1 = 898.293
 fy1 = 748.5775
  su1 = 0.032
    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 = 1.00
     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, ASCE 41-17.
      with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 748.5775
      with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.0025
  sh2 = 0.008
 ft2 = 886.7403
 fy2 = 738.9503
  su2 = 0.032
    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 = 1.00
     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, ASCE 41-17.
      with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 738.9503
      with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.0025
  shv = 0.008
 ftv = 894.3662
 fyv = 745.3052
  suv = 0.032
    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 = 1.00
     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, ASCE 41-17.
      with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052

with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
    ρ1 = Asl,ten/(b*d)*(fs1/fc) = 0.7508007
    ρ2 = Asl,com/(b*d)*(fs2/fc) = 0.38164216
    ρv = Asl,mid/(b*d)*(fsv/fc) = 0.67946571
and confined core properties:
  b = 160.00
  d = 347.00
  d' = 13.00
  fcc (5A.2, TBDY) = 30.00
   εcc (5A.5, TBDY) = 0.002
      c = confinement factor = 1.00
    ρ1 = Asl,ten/(b*d)*(fs1/fc) = 0.99259314
    ρ2 = Asl,com/(b*d)*(fs2/fc) = 0.50454853
    ρv = Asl,mid/(b*d)*(fsv/fc) = 0.898285
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
  ' satisfies Eq. (4.4)
--->
v < εs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is not satisfied
--->
 εcu (4.11) = 0.80138156
MRc (4.18) = 5.4612E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
   - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
   - N, ρ1, ρ2, ρv normalised to bo*do, instead of b*d
   - ε - parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 ε*cu (4.11) = 0.80674817
MRo (4.18) = 2.8580E+008
MRo < 0.8*MRc
--->
 φu = εcu (unconfined full section) = 3.1475172E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1


```
-------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 339150.739
-------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 339150.739
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 339150.739
  knl = 1 (zero step-static loading)
--------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+  f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
--------------------------------------------------------------
    = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
    Mu = 6.7415E+007
    Vu = 3.6347847E-006
  d = 0.8*h = 320.00
  Nu = 1.8026E+006
  Ag = 80000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 471238.898
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 471238.898
  Vs,j1 = 157079.633 is calculated for section web jacket, with:
    d = 160.00
    Av = 157079.633
    fy = 625.00
    s = 100.00
  Vs,j1 is multiplied by   Col,j1 = 1.00
    s/d = 0.625
  Vs,j2 = 314159.265 is calculated for section flange jacket, with:
    d = 320.00
    Av = 157079.633
    fy = 625.00
    s = 100.00
  Vs,j2 is multiplied by   Col,j2 = 1.00
    s/d = 0.3125
  Vs,core = Vs,c1 + Vs,c2 = 0.00
  Vs,c1 = 0.00 is calculated for section web core, with:
    d = 80.00
    Av = 100530.965
    fy = 500.00
    s = 250.00
  Vs,c1 is multiplied by   Col,c1 = 0.00
    s/d = 3.125
  Vs,c2 = 0.00 is calculated for section flange core, with:
    d = 240.00
    Av = 100530.965
    fy = 500.00
    s = 250.00
  Vs,c2 is multiplied by   Col,c2 = 0.00
    s/d = 1.04167
  Vf ((11-3)-(11.4), ACI 440) = 0.00
  From (11-11), ACI 440: Vs + Vf <= 212577.225
    bw = 200.00
--------------------------------------------------------------
---------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 339150.739
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 339150.739
  knl = 1 (zero step-static loading)
--------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+  f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
--------------------------------------------------------------
    = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3
```

MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
    Mu = 5.3429E+007
    Vu = 3.6347847E-006
  d = 0.8*h = 320.00
  Nu = 1.8026E+006
  Ag = 80000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 471238.898
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 471238.898
  Vs,j1 = 157079.633 is calculated for section web jacket, with:
    d = 160.00
    Av = 157079.633
    fy = 625.00
    s = 100.00
  Vs,j1 is multiplied by   Col,j1 = 1.00
    s/d = 0.625
  Vs,j2 = 314159.265 is calculated for section flange jacket, with:
    d = 320.00
    Av = 157079.633
    fy = 625.00
    s = 100.00
  Vs,j2 is multiplied by   Col,j2 = 1.00
    s/d = 0.3125
  Vs,core = Vs,c1 + Vs,c2 = 0.00
  Vs,c1 = 0.00 is calculated for section web core, with:
    d = 80.00
    Av = 100530.965
    fy = 500.00
    s = 250.00
  Vs,c1 is multiplied by   Col,c1 = 0.00
    s/d = 3.125
  Vs,c2 = 0.00 is calculated for section flange core, with:
    d = 240.00
    Av = 100530.965
    fy = 500.00
    s = 250.00
  Vs,c2 is multiplied by   Col,c2 = 0.00
    s/d = 1.04167
  Vf ((11-3)-(11.4), ACI 440) = 0.00
  From (11-11), ACI 440: Vs + Vf <= 212577.225
    bw = 200.00

End Of Calculation of Shear Capacity ratio for element: column JLC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column JLC1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rcjlcs

Constant Properties

Knowledge Factor,   = 0.90
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 30.00
New material of Secondary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00
Existing Column

Existing material of Secondary Member: Concrete Strength, fc = fcm = 18.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 500.00
Concrete Elasticity, Ec = 19940.411
Steel Elasticity, Es = 200000.00
Max Height, Hmax = 400.00
Min Height, Hmin = 200.00
Max Width, Wmax = 400.00
Min Width, Wmin = 200.00
Jacket Thickness, tj = 50.00
Cover Thickness, c = 15.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lb/ld>=1)
No FRP Wrapping

Stepwise Properties

Bending Moment, M = 1.1948E+007
Shear Force, V2 = -62256.122
Shear Force, V3 = -174.4443
Axial Force, F = -1.8013E+006
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 2161.416
     -Compression: Aslc = 3191.858
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1137.257
     -Compression: Asl,com = 2208.54
       -Middle: Asl,mid = 2007.478
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,jacket = 829.3805
     -Compression: Asl,com,jacket = 1746.726
       -Middle: Asl,mid,jacket = 1545.664
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,core = 307.8761
     -Compression: Asl,com,core = 461.8141
       -Middle: Asl,mid,core = 461.8141
Mean Diameter of Tension Reinforcement, DbL = 16.80

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = * θu = 0.0380477
 θu = θy + θp = 0.04227522

 - Calculation of θy -

 θy = (My*Ls/3)/EIeff = 0.02957008 ((4.29),Biskinis Phd))
  My = 3.6891E+008
  Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 6000.00
  From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 2.4951E+013
    factor = 0.70
      Ag = 120000.00
      Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00
      N = 1.8013E+006
    Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.5645E+013

Calculation of Yielding Moment My

Calculation of θy and My according to Annex 7 -

----
  y = Min(y_ten, y_com)
  y_ten = 1.6454016E-005
 with fy = 596.2441
    d = 367.00
     y = 0.50630795
    A = 0.11409279
    B = 0.07426396
     with pt = 0.01549396
        pc = 0.0300891
        pv = 0.02734983
        N = 1.8013E+006
        b = 200.00
        " = 0.08991826
  y_comp = 9.3125388E-006
 with fc = 30.00
   Ec = 25742.96
    y = 0.61376358
   A = 0.01443594
   B = 0.03310406
    with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

 - Calculation of p -

From table 10-8: p = 0.01270514
with:
 - Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
  shear control ratio VyE/VCol0E = 1.44151
  d = d_external = 367.00
  s = s_external = 100.00
 - t = s1 + s2 + 2*tf/bw*(ffe/fs) = 0.00809358
  jacket: s1 = Av1*Lstir1/(s1*Ag) = 0.00680678
      Av1 = 78.53982, is the area of every stirrup parallel to loading (shear) direction
      Lstir1 = 1040.00, is the total Length of all stirrups parallel to loading (shear) direction
      s1 = 100.00
  core: s2 = Av2*Lstir2/(s2*Ag) = 0.0012868
      Av2 = 50.26548, is the area of every stirrup parallel to loading (shear) direction
      Lstir2 = 768.00, is the total Length of all stirrups parallel to loading (shear) direction
      s2 = 250.00
  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.
  For the normalisation fs of jacket is used.
   NUD = 1.8013E+006
   Ag = 120000.00
   f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 25.00
   fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein =
596.2441
   fytE = (fy_ext_Trans_Reinf* s1+fy_int_Trans_Reinf* s2)/(s1+ s2) = 605.1263
pl = Area_Tot_Long_Rein/(b*d) = 0.07293289
  b = 200.00
  d = 367.00
  f'cE = 25.00

End Of Calculation of Chord Rotation Capacity for element: column JLC1 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 50 and 51)

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (3)

Start Of Calculation of Shear Capacity for element: column JLC1 of floor 1
At local axis: 3
Integration Section: (a)
Section Type: rcjlcs

Constant Properties

Knowledge Factor,   = 0.90
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 12.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 19940.411
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, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 30.00
New material: Steel Strength, fs = fsm = 625.00

Existing Column
Existing material: Concrete Strength, fc = fcm = 18.00
Existing material: Steel Strength, fs = fsm = 500.00
###
Max Height, Hmax = 400.00
Min Height, Hmin = 200.00
Max Width, Wmax = 400.00
Min Width, Wmin = 200.00
Jacket Thickness, tj = 50.00
Cover Thickness, c = 15.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min = lb/ld >=1)
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = 1.1948E+007
Shear Force, Va = -174.4443
EDGE -B-
Bending Moment, Mb = 246078.073
Shear Force, Vb = 174.4443
BOTH EDGES
Axial Force, F = -1.8013E+006
Longitudinal Reinforcement Area Distribution (in 2 divisions)
       -Tension: Aslt = 2161.416
     -Compression: Aslc = 3191.858
Longitudinal Reinforcement Area Distribution (in 3 divisions)
       -Tension: Asl,ten = 1137.257
     -Compression: Asl,com = 2208.54
         -Middle: Asl,mid = 2007.478
Mean Diameter of Tension Reinforcement, DbL,ten = 16.80

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR =   *Vn = 258166.022
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 286851.135
   VCol = 286851.135
   knl = 1.00
       displacement_ductility_demand = 0.07294981

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

    = 1 (normal-weight concrete)
   Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 16.66667, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
   M/Vd = 4.00
      Mu = 1.1948E+007
      Vu = 174.4443
   d = 0.8*h = 320.00
   Nu = 1.8013E+006
   Ag = 80000.00
   From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 376991.118
   where:
   Vs,jacket = Vs,j1 + Vs,j2 = 376991.118
   Vs,j1 = 251327.412 is calculated for section web jacket, with:
      d = 320.00
      Av = 157079.633
      fy = 500.00

```
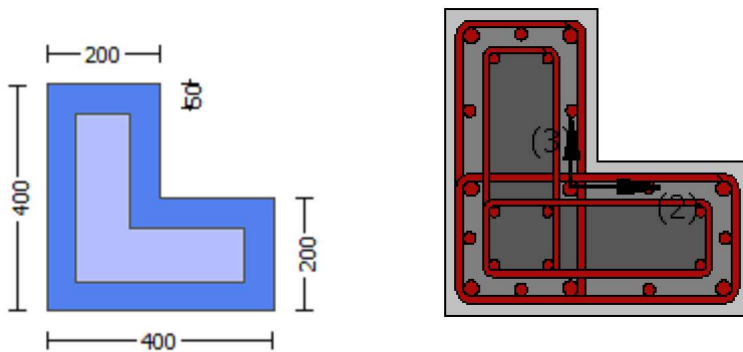        s = 100.00
   Vs,j1 is multiplied by   Col,j1 = 1.00
       s/d = 0.3125
   Vs,j2 = 125663.706 is calculated for section flange jacket, with:
       d = 160.00
       Av = 157079.633
       fy = 500.00
       s = 100.00
   Vs,j2 is multiplied by   Col,j2 = 1.00
       s/d = 0.625
  Vs,core = Vs,c1 + Vs,c2 = 0.00
   Vs,c1 = 0.00 is calculated for section web core, with:
       d = 240.00
       Av = 100530.965
       fy = 400.00
       s = 250.00
   Vs,c1 is multiplied by   Col,c1 = 0.00
       s/d = 1.04167
   Vs,c2 = 0.00 is calculated for section flange core, with:
       d = 80.00
       Av = 100530.965
       fy = 400.00
       s = 250.00
   Vs,c2 is multiplied by   Col,c2 = 0.00
       s/d = 3.125
   Vf ((11-3)-(11.4), ACI 440) = 0.00
   From (11-11), ACI 440: Vs + Vf <= 173568.578
       bw = 200.00
----------------------------------------------------------

----------------------------------------------------------
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    = 0.00215713
  y = (My*Ls/3)/Eleff = 0.02957008 ((4.29),Biskinis Phd))
  My = 3.6891E+008
  Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 6000.00
  From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 2.4951E+013
     factor = 0.70
       Ag = 120000.00
       Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00
       N = 1.8013E+006
     Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.5645E+013
----------------------------------------------------------
----------------------------------------------------------

Calculation of Yielding Moment My
----------------------------------------------------------
Calculation of   y and My according to Annex 7   -
----------------------------------------------------------
  y = Min(  y_ten,  y_com)
  y_ten = 1.6454016E-005
 with fy = 596.2441
     d = 367.00
      y = 0.50630795
     A = 0.11409279
     B = 0.07426396
     with pt = 0.01549396
        pc = 0.0300891
        pv = 0.02734983
        N = 1.8013E+006
        b = 200.00
        " = 0.08991826
  y_comp = 9.3125388E-006
```

with fc = 30.00
   Ec = 25742.96
    y = 0.61376358
   A = 0.01443594
   B = 0.03310406
    with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

End Of Calculation of Shear Capacity for element: column JLC1 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 50 and 51)

Analysis: Uniform +X

Check: Chord rotation capacity (u)

Edge: Start

Local Axis: (3)

Start Of Calculation of Shear Capacity ratio for element: column JLC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcjlcs

Constant Properties

Knowledge Factor,   = 0.90
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 30.00

New material of Secondary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 18.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 500.00
Concrete Elasticity, Ec = 19940.411
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
Jacket
New material: Steel Strength, fs = 1.25*fsm = 781.25
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 625.00
##
Max Height, Hmax = 400.00
Min Height, Hmin = 200.00
Max Width, Wmax = 400.00
Min Width, Wmin = 200.00
Jacket Thickness, tj = 50.00
Cover Thickness, c = 15.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = 2.3476251E-006
EDGE -B-
Shear Force, Vb = -2.3476251E-006
BOTH EDGES
Axial Force, F = -1.8026E+006
Longitudinal Reinforcement Area Distribution (in 2 divisions)
     -Tension: Aslt = 0.00
   -Compression: Aslc = 5353.274
Longitudinal Reinforcement Area Distribution (in 3 divisions)
     -Tension: Asl,ten = 2208.54
   -Compression: Asl,com = 1137.257
     -Middle: Asl,mid = 2007.478

Calculation of Shear Capacity ratio , Ve/Vr = 1.44151
Member Controlled by Shear (Ve/Vr > 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 488890.189
with
Mpr1 = Max(Mu1+ , Mu1-) = 7.3334E+008
  Mu1+ = 7.3334E+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- = 6.3768E+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-) = 7.3334E+008
  Mu2+ = 7.3334E+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- = 6.3768E+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 = 4.2207094E-005
Mu = 7.3334E+008
----
with full section properties:
  b = 400.00
  d = 367.00
  d' = 33.00
  ν = 0.40931126
    N = 1.8026E+006
  fc = 30.00
  εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.00925707
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.00925707
      we (5.4c) = 0.0207149
      αse ((5.4d), TBDY) = (αse1*Aext+αse2*Aint)/Asec = 0.33836562
        αse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
        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,max1 = 89600.00 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 external perimeter hoops.
        Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
              is calculated by reducing all the dimensions of the area Aconf,max1 by a length
              equal to half the clear spacing between external hoops.
        AnoConf1 = 43733.333 is the unconfined external core area which is equal to Σbi2/6 as defined at (A.2).
      αse2 (>=αse1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
        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,max2 = 45264.00 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 internal perimeter hoops.
        Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
              is calculated by reducing all the dimensions of the area Aconf,max2 by a length
              equal to half the clear spacing between internal hoops.
        AnoConf2 = 32309.333 is the unconfined internal core area which is equal to Σbi2/6 as defined at (A.2).
      ρsh,min*Fywe = Min(ρsh,x*Fywe, ρsh,y*Fywe) = 6.12205
    Expression (5.4d) for ρsh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

        ρsh_x*Fywe = ρsh1*Fywe1+ρs2*Fywe2 = 6.12205
        ρsh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
          Lstir1 (Length of stirrups along Y) = 1040.00
          Astir1 (stirrups area) = 78.53982
        ρsh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
          Lstir2 (Length of stirrups along Y) = 768.00
          Astir2 (stirrups area) = 50.26548

        ρsh_y*Fywe = ρsh1*Fywe1+ρs2*Fywe2 = 6.12205
        ρsh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
          Lstir1 (Length of stirrups along X) = 1040.00
          Astir1 (stirrups area) = 78.53982
        ρsh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
          Lstir2 (Length of stirrups along X) = 768.00
          Astir2 (stirrups area) = 50.26548

```
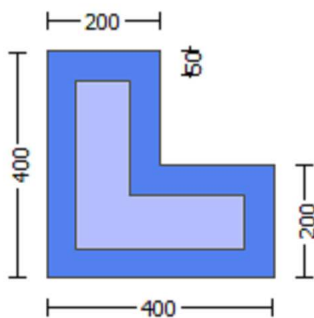            Asec = 120000.00
              s1 = 100.00
              s2 = 250.00
           fywe1 = 781.25
           fywe2 = 625.00
            fce = 30.00
      From ((5.A5), TBDY),  TBDY:  cc = 0.002
           c = confinement factor = 1.00
    y1 = 0.0025
   sh1 = 0.008
  ft1 = 898.293
 fy1 = 748.5775
    su1 = 0.032
     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 = 1.00
      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, ASCE 41-17.
       with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 748.5775
       with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
    y2 = 0.0025
   sh2 = 0.008
  ft2 = 886.7403
 fy2 = 738.9503
    su2 = 0.032
     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 = 1.00
      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, ASCE 41-17.
       with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 738.9503
       with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
    yv = 0.0025
   shv = 0.008
  ftv = 894.3662
 fyv = 745.3052
    suv = 0.032
     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 = 1.00
      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, ASCE 41-17.
       with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
       with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.37540035
    2 = Asl,com/(b*d)*(fs2/fc) = 0.19082108
    v = Asl,mid/(b*d)*(fsv/fc) = 0.33973286
 and confined core properties:
   b = 360.00
   d = 347.00
   d' = 13.00
   fcc (5A.2, TBDY) = 30.00
    cc (5A.5, TBDY) = 0.002
       c = confinement factor = 1.00
```

1 = Asl,ten/(b*d)*(fs1/fc) = 0.44115251
        2 = Asl,com/(b*d)*(fs2/fc) = 0.22424379
        v = Asl,mid/(b*d)*(fsv/fc) = 0.39923778
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
    ' satisfies Eq. (4.4)
--->
v <   s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
  cu (4.10) = 0.59761571
MRc (4.17) = 7.3334E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
    - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
    - N,   1,   2,   v normalised to bo*do, instead of b*d
    -   -   parameters of confined concrete, fcc,   cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
  *cu (4.11) = 0.62879536
MRo (4.18) = 4.5866E+008
MRo < 0.8*MRc
--->
  u =   cu (unconfined full section) =   4.2207094E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 4.8346386E-005
Mu = 6.3768E+008
----
with full section properties:
  b = 200.00
  d = 367.00

d' = 33.00
v = 0.81862252
 N = 1.8026E+006
fc = 30.00
 co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00925707
  The Shear_factor is considered equal to 1 (pure moment strength)
  From (5.4b), TBDY: cu = 0.00925707
   we (5.4c) = 0.0207149
   ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.33836562
     ase1 = Max((((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
     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,max1 = 89600.00 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 external perimeter hoops.
     Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
          is calculated by reducing all the dimensions of the area Aconf,max1 by a length
          equal to half the clear spacing between external hoops.
     AnoConf1 = 43733.333 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
   ase2 (>=ase1) = Max((((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
     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,max2 = 45264.00 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 internal perimeter hoops.
     Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
          is calculated by reducing all the dimensions of the area Aconf,max2 by a length
          equal to half the clear spacing between internal hoops.
     AnoConf2 = 32309.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
   psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
  Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
    ----
     psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
     psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
       Lstir1 (Length of stirrups along Y) = 1040.00
       Astir1 (stirrups area) = 78.53982
     psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
       Lstir2 (Length of stirrups along Y) = 768.00
       Astir2 (stirrups area) = 50.26548
    ----
     psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
     psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
       Lstir1 (Length of stirrups along X) = 1040.00
       Astir1 (stirrups area) = 78.53982
     psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
       Lstir2 (Length of stirrups along X) = 768.00
       Astir2 (stirrups area) = 50.26548

     Asec = 120000.00
     s1 = 100.00
     s2 = 250.00
    fywe1 = 781.25
    fywe2 = 625.00
    fce = 30.00
  From ((5.A5), TBDY), TBDY: cc = 0.002
     c = confinement factor = 1.00
 y1 = 0.0025
 sh1 = 0.008
ft1 = 886.7403
fy1 = 738.9503
 su1 = 0.032

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 = 1.00
 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, ASCE 41-17.
 with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 738.9503
 with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
 y2 = 0.0025
 sh2 = 0.008
ft2 = 898.293
fy2 = 748.5775
 su2 = 0.032
 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 = 1.00
 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, ASCE 41-17.
 with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 748.5775
 with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
 yv = 0.0025
 shv = 0.008
ftv = 894.3662
fyv = 745.3052
 suv = 0.032
 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 = 1.00
 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, ASCE 41-17.
 with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
 with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.38164216
 2 = Asl,com/(b*d)*(fs2/fc) = 0.7508007
 v = Asl,mid/(b*d)*(fsv/fc) = 0.67946571
and confined core properties:
 b = 160.00
 d = 347.00
 d' = 13.00
 fcc (5A.2, TBDY) = 30.00
 cc (5A.5, TBDY) = 0.002
 c = confinement factor = 1.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.50454853
 2 = Asl,com/(b*d)*(fs2/fc) = 0.99259314
 v = Asl,mid/(b*d)*(fsv/fc) = 0.898285
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover

' satisfies Eq. (4.4)
--->
v < s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
 cu (4.10) = 0.52172715
MRc (4.17) = 6.3768E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N, 1, 2, v normalised to bo*do, instead of b*d
  - - parameters of confined concrete, fcc, cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 *cu (4.11) = 0.5604845
MRo (4.18) = 4.7738E+008
MRo < 0.8*MRc
--->
 u = cu (unconfined full section) = 4.8346386E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 u = 4.2207094E-005
Mu = 7.3334E+008
----
with full section properties:
  b = 400.00
  d = 367.00
  d' = 33.00
  v = 0.40931126
    N = 1.8026E+006
  fc = 30.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00925707
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00925707
      we (5.4c) = 0.0207149
       ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.33836562
         ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
         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,max1 = 89600.00 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 external perimeter hoops.
Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
    is calculated by reducing all the dimensions of the area Aconf,max1 by a length
    equal to half the clear spacing between external hoops.
AnoConf1 = 43733.333 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
    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,max2 = 45264.00 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 internal perimeter hoops.
Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
    is calculated by reducing all the dimensions of the area Aconf,max2 by a length
    equal to half the clear spacing between internal hoops.
AnoConf2 = 32309.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
    ----
    psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
    psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
        Lstir1 (Length of stirrups along Y) = 1040.00
        Astir1 (stirrups area) = 78.53982
    psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
        Lstir2 (Length of stirrups along Y) = 768.00
        Astir2 (stirrups area) = 50.26548
    ----
    psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
    psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
        Lstir1 (Length of stirrups along X) = 1040.00
        Astir1 (stirrups area) = 78.53982
    psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
        Lstir2 (Length of stirrups along X) = 768.00
        Astir2 (stirrups area) = 50.26548

        Asec = 120000.00
        s1 = 100.00
        s2 = 250.00
     fywe1 = 781.25
     fywe2 = 625.00
     fce = 30.00
    From ((5.A5), TBDY), TBDY: cc = 0.002
        c = confinement factor = 1.00
  y1 = 0.0025
  sh1 = 0.008
 ft1 = 898.293
 fy1 = 748.5775
 su1 = 0.032
    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 = 1.00
     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, ASCE 41-17.
      with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 748.5775
      with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.0025
  sh2 = 0.008

ft2 = 886.7403
fy2 = 738.9503
 su2 = 0.032
   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 = 1.00
    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, ASCE 41-17.
     with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 738.9503
     with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.0025
  shv = 0.008
 ftv = 894.3662
 fyv = 745.3052
  suv = 0.032
   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 = 1.00
    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, ASCE 41-17.
     with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
     with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.37540035
  2 = Asl,com/(b*d)*(fs2/fc) = 0.19082108
  v = Asl,mid/(b*d)*(fsv/fc) = 0.33973286
and confined core properties:
  b = 360.00
  d = 347.00
  d' = 13.00
 fcc (5A.2, TBDY) = 30.00
  cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.44115251
  2 = Asl,com/(b*d)*(fs2/fc) = 0.22424379
  v = Asl,mid/(b*d)*(fsv/fc) = 0.39923778
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
 ' satisfies Eq. (4.4)
--->
v <   s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
 cu (4.10) = 0.59761571
MRc (4.17) = 7.3334E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N, 1, 2, v normalised to bo*do, instead of b*d

- - parameters of confined concrete, fcc, εcc, used in lieu of fc, εcu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 ε*cu (4.11) = 0.62879536
MRo (4.18) = 4.5866E+008
MRo < 0.8*MRc
--->
 εu = εcu (unconfined full section) = 4.2207094E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
 φu = 4.8346386E-005
Mu = 6.3768E+008
----
with full section properties:
 b = 200.00
 d = 367.00
 d' = 33.00
 ν = 0.81862252
   N = 1.8026E+006
 fc = 30.00
  εco (5A.5, TBDY) = 0.002
 Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.00925707
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.00925707
      ωwe (5.4c) = 0.0207149
       αse ((5.4d), TBDY) = (αse1*Aext+αse2*Aint)/Asec = 0.33836562
         αse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
         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,max1 = 89600.00 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 external perimeter hoops.
         Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
                 is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                 equal to half the clear spacing between external hoops.
         AnoConf1 = 43733.333 is the unconfined external core area which is equal to Σbi2/6 as defined at (A.2).
       αse2 (>=αse1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
         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,max2 = 45264.00 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 internal perimeter hoops.
Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 32309.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
Lstir1 (Length of stirrups along Y) = 1040.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
Lstir2 (Length of stirrups along Y) = 768.00
Astir2 (stirrups area) = 50.26548

----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
Lstir1 (Length of stirrups along X) = 1040.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
Lstir2 (Length of stirrups along X) = 768.00
Astir2 (stirrups area) = 50.26548

Asec = 120000.00
s1 = 100.00
s2 = 250.00
fywe1 = 781.25
fywe2 = 625.00
fce = 30.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.0025
sh1 = 0.008
ft1 = 886.7403
fy1 = 738.9503
su1 = 0.032
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 = 1.00
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, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 738.9503
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 898.293
fy2 = 748.5775
su2 = 0.032
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 = 1.00
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, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 748.5775

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
   yv = 0.0025
   shv = 0.008
  ftv = 894.3662
  fyv = 745.3052
   suv = 0.032
    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 = 1.00
     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, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.38164216
  2 = Asl,com/(b*d)*(fs2/fc) = 0.7508007
  v = Asl,mid/(b*d)*(fsv/fc) = 0.67946571
and confined core properties:
  b = 160.00
  d = 347.00
  d' = 13.00
  fcc (5A.2, TBDY) = 30.00
   cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.50454853
   2 = Asl,com/(b*d)*(fs2/fc) = 0.99259314
   v = Asl,mid/(b*d)*(fsv/fc) = 0.898285
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
 ' satisfies Eq. (4.4)
--->
v <   s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
 cu (4.10) = 0.52172715
MRc (4.17) = 6.3768E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N,   1,   2,   v normalised to bo*do, instead of b*d
  -   - parameters of confined concrete, fcc,   cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied

--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 *cu (4.11) = 0.5604845
MRo (4.18) = 4.7738E+008
MRo < 0.8*MRc
--->
 u =   cu (unconfined full section) = 4.8346386E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 339150.739

Calculation of Shear Strength at edge 1, Vr1 = 339150.739
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 339150.739
  knl = 1 (zero step-static loading)

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

    = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
    Mu = 2.0345E+006
    Vu = 2.3476251E-006
  d = 0.8*h = 320.00
  Nu = 1.8026E+006
  Ag = 80000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 471238.898
  where:
 Vs,jacket = Vs,j1 + Vs,j2 = 471238.898
 Vs,j1 = 314159.265 is calculated for section web jacket, with:
    d = 320.00
    Av = 157079.633
    fy = 625.00
    s = 100.00
 Vs,j1 is multiplied by   Col,j1 = 1.00
    s/d = 0.3125
 Vs,j2 = 157079.633 is calculated for section flange jacket, with:
    d = 160.00
    Av = 157079.633
    fy = 625.00
    s = 100.00
 Vs,j2 is multiplied by   Col,j2 = 1.00
    s/d = 0.625
 Vs,core = Vs,c1 + Vs,c2 = 0.00
 Vs,c1 = 0.00 is calculated for section web core, with:
    d = 240.00
    Av = 100530.965
    fy = 500.00
    s = 250.00
 Vs,c1 is multiplied by   Col,c1 = 0.00
    s/d = 1.04167
 Vs,c2 = 0.00 is calculated for section flange core, with:
    d = 80.00
    Av = 100530.965
    fy = 500.00
    s = 250.00

Vs,c2 is multiplied by   Col,c2 = 0.00
   s/d = 3.125
  Vf ((11-3)-(11.4), ACI 440) = 0.00
  From (11-11), ACI 440: Vs + Vf <= 212577.225
   bw = 200.00

Calculation of Shear Strength at edge 2, Vr2 = 339150.739
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 339150.739
  knl = 1 (zero step-static loading)

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

   = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
   Mu = 6739.685
   Vu = 2.3476251E-006
  d = 0.8*h = 320.00
  Nu = 1.8026E+006
  Ag = 80000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 471238.898
  where:
 Vs,jacket = Vs,j1 + Vs,j2 = 471238.898
 Vs,j1 = 314159.265 is calculated for section web jacket, with:
   d = 320.00
   Av = 157079.633
   fy = 625.00
   s = 100.00
 Vs,j1 is multiplied by   Col,j1 = 1.00
   s/d = 0.3125
 Vs,j2 = 157079.633 is calculated for section flange jacket, with:
   d = 160.00
   Av = 157079.633
   fy = 625.00
   s = 100.00
 Vs,j2 is multiplied by   Col,j2 = 1.00
   s/d = 0.625
 Vs,core = Vs,c1 + Vs,c2 = 0.00
 Vs,c1 = 0.00 is calculated for section web core, with:
   d = 240.00
   Av = 100530.965
   fy = 500.00
   s = 250.00
 Vs,c1 is multiplied by   Col,c1 = 0.00
   s/d = 1.04167
 Vs,c2 = 0.00 is calculated for section flange core, with:
   d = 80.00
   Av = 100530.965
   fy = 500.00
   s = 250.00
 Vs,c2 is multiplied by   Col,c2 = 0.00
   s/d = 3.125
  Vf ((11-3)-(11.4), ACI 440) = 0.00
  From (11-11), ACI 440: Vs + Vf <= 212577.225
   bw = 200.00

End Of Calculation of Shear Capacity ratio for element: column JLC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column JLC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjlcs

Constant Properties

Knowledge Factor,   = 0.90
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 30.00
New material of Secondary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 18.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 500.00
Concrete Elasticity, Ec = 19940.411
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
Jacket
New material: Steel Strength, fs = 1.25*fsm = 781.25
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 625.00
##
Max Height, Hmax = 400.00
Min Height, Hmin = 200.00
Max Width, Wmax = 400.00
Min Width, Wmin = 200.00
Jacket Thickness, tj = 50.00
Cover Thickness, c = 15.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = -3.6347847E-006
EDGE -B-
Shear Force, Vb = 3.6347847E-006
BOTH EDGES
Axial Force, F = -1.8026E+006
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
    -Compression: Aslc = 5353.274
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 1137.257
    -Compression: Asl,com = 2208.54
       -Middle: Asl,mid = 2007.478

Calculation of Shear Capacity ratio , Ve/Vr = 1.18753
Member Controlled by Shear (Ve/Vr > 1)

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 402750.026
with
Mpr1 = Max(Mu1+ , Mu1-) = 6.0413E+008
   Mu1+ = 6.0413E+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- = 5.4612E+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-) = 6.0413E+008
   Mu2+ = 6.0413E+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- = 5.4612E+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 = 1.2613948E-005
Mu = 6.0413E+008
----
with full section properties:
  b = 400.00
  d = 367.00
  d' = 33.00
  ν = 0.40931126
    N = 1.8026E+006
  fc = 30.00
   εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.00925707
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: εcu = 0.00925707
       αωe (5.4c) = 0.0207149
       αse ((5.4d), TBDY) = (αse1*Aext+αse2*Aint)/Asec = 0.33836562
          αse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
          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,max1 = 89600.00 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 external perimeter hoops.
          Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
                  is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                  equal to half the clear spacing between external hoops.
          AnoConf1 = 43733.333 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
        αse2 (>=αse1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
          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,max2 = 45264.00 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 internal perimeter hoops.
          Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
                  is calculated by reducing all the dimensions of the area Aconf,max2 by a length
                  equal to half the clear spacing between internal hoops.
          AnoConf2 = 32309.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
       ρsh,min*Fywe = Min(ρsh,x*Fywe , ρsh,y*Fywe) = 6.12205
    Expression (5.4d) for ρsh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

          ρsh_x*Fywe = ρsh1*Fywe1+ρs2*Fywe2 = 6.12205
          ρsh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
             Lstir1 (Length of stirrups along Y) = 1040.00
             Astir1 (stirrups area) = 78.53982

psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
 Lstir2 (Length of stirrups along Y) = 768.00
 Astir2 (stirrups area) = 50.26548
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
 Lstir1 (Length of stirrups along X) = 1040.00
 Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
 Lstir2 (Length of stirrups along X) = 768.00
 Astir2 (stirrups area) = 50.26548

Asec = 120000.00
s1 = 100.00
s2 = 250.00
fywe1 = 781.25
fywe2 = 625.00
fce = 30.00
From ((5.A5), TBDY), TBDY: cc = 0.002
 c = confinement factor = 1.00
y1 = 0.0025
sh1 = 0.008
ft1 = 886.7403
fy1 = 738.9503
su1 = 0.032
 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 = 1.00
 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, ASCE 41-17.
 with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 738.9503
 with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 898.293
fy2 = 748.5775
su2 = 0.032
 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 = 1.00
 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, ASCE 41-17.
 with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 748.5775
 with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 894.3662
fyv = 745.3052
suv = 0.032
 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 = 1.00
 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, ASCE 41-17.

with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.19082108
2 = Asl,com/(b*d)*(fs2/fc) = 0.37540035
v = Asl,mid/(b*d)*(fsv/fc) = 0.33973286
and confined core properties:
  b = 360.00
  d = 347.00
  d' = 13.00
  fcc (5A.2, TBDY) = 30.00
   cc (5A.5, TBDY) = 0.002
      c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.22424379
    2 = Asl,com/(b*d)*(fs2/fc) = 0.44115251
    v = Asl,mid/(b*d)*(fsv/fc) = 0.39923778
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
 ' satisfies Eq. (4.4)
--->
v <   s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
 cu (4.10) = 0.37716748
MRc (4.17) = 7.0585E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N, 1, 2, v normalised to bo*do, instead of b*d
  - - parameters of confined concrete, fcc, cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 *cu (4.11) = 0.4569298
MRo (4.18) = 6.0413E+008
--->
  u =   cu (4.2) = 1.2613948E-005
Mu = MRo

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
  u = 3.1475172E-005
Mu = 5.4612E+008

----

with full section properties:
  b = 200.00
  d = 367.00
  d' = 33.00
  v = 0.81862252
    N = 1.8026E+006
  fc = 30.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00925707
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00925707
      we (5.4c) = 0.0207149
       ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.33836562
         ase1 = Max((((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
         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,max1 = 89600.00 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 external perimeter hoops.
         Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
                 is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                 equal to half the clear spacing between external hoops.
      AnoConf1 = 43733.333 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
       ase2 (>=ase1) = Max((((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
         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,max2 = 45264.00 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 internal perimeter hoops.
         Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
                 is calculated by reducing all the dimensions of the area Aconf,max2 by a length
                 equal to half the clear spacing between internal hoops.
      AnoConf2 = 32309.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
      psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
    Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
       ----
         psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
         psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
           Lstir1 (Length of stirrups along Y) = 1040.00
           Astir1 (stirrups area) = 78.53982
         psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
           Lstir2 (Length of stirrups along Y) = 768.00
           Astir2 (stirrups area) = 50.26548
       ----
         psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
         psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
           Lstir1 (Length of stirrups along X) = 1040.00
           Astir1 (stirrups area) = 78.53982
         psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
           Lstir2 (Length of stirrups along X) = 768.00
           Astir2 (stirrups area) = 50.26548

         Asec = 120000.00
         s1 = 100.00

```
                s2 = 250.00
             fywe1 = 781.25
             fywe2 = 625.00
              fce = 30.00
          From ((5.A5), TBDY), TBDY:  cc = 0.002
               c = confinement factor = 1.00
       y1 = 0.0025
      sh1 = 0.008
     ft1 = 898.293
     fy1 = 748.5775
      su1 = 0.032
        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 = 1.00
         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, ASCE 41-17.
         with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 748.5775
         with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
       y2 = 0.0025
      sh2 = 0.008
     ft2 = 886.7403
     fy2 = 738.9503
      su2 = 0.032
        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 = 1.00
         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, ASCE 41-17.
         with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 738.9503
         with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
       yv = 0.0025
      shv = 0.008
     ftv = 894.3662
     fyv = 745.3052
      suv = 0.032
        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 = 1.00
         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, ASCE 41-17.
         with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
         with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
       1 = Asl,ten/(b*d)*(fs1/fc) = 0.7508007
       2 = Asl,com/(b*d)*(fs2/fc) = 0.38164216
       v = Asl,mid/(b*d)*(fsv/fc) = 0.67946571
and confined core properties:
   b = 160.00
   d = 347.00
   d' = 13.00
   fcc (5A.2, TBDY) = 30.00
    cc (5A.5, TBDY) = 0.002
       c = confinement factor = 1.00
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.99259314
     2 = Asl,com/(b*d)*(fs2/fc) = 0.50454853
```

```
      v = Asl,mid/(b*d)*(fsv/fc) = 0.898285
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
  ' satisfies Eq. (4.4)
--->
v <    s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is not satisfied
--->
  cu (4.11) = 0.80138156
MRc (4.18) = 5.4612E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N,   1,   2,   v normalised to bo*do, instead of b*d
  -  -   parameters of confined concrete, fcc,   cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
  *cu (4.11) = 0.80674817
MRo (4.18) = 2.8580E+008
MRo < 0.8*MRc
--->
  u =    cu (unconfined full section) =   3.1475172E-005
Mu = MRc
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
----------------------------------------------------------------------
----------------------------------------------------------------------
----------------------------------------------------------------------
Calculation of Mu2+
----------------------------------------------------------------------

----------------------------------------------------------------------
Calculation of ultimate curvature    u according to 4.1, Biskinis/Fardis 2013:
  u = 1.2613948E-005
Mu = 6.0413E+008
----------------------------------------------------------------------
with full section properties:
  b = 400.00
  d = 367.00
  d' = 33.00
  v = 0.40931126
```

N = 1.8026E+006
fc = 30.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00925707
   The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00925707
     we (5.4c) = 0.0207149
      ase ((5.4d), TBDY) = (ase1*Aext+ ase2*Aint)/Asec = 0.33836562
        ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
        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,max1 = 89600.00 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 external perimeter hoops.
        Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
            is calculated by reducing all the dimensions of the area Aconf,max1 by a length
            equal to half the clear spacing between external hoops.
        AnoConf1 = 43733.333 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
      ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
        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,max2 = 45264.00 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 internal perimeter hoops.
        Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
          is calculated by reducing all the dimensions of the area Aconf,max2 by a length
          equal to half the clear spacing between internal hoops.
        AnoConf2 = 32309.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
      psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
   Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
     ----
     psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
     psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
       Lstir1 (Length of stirrups along Y) = 1040.00
       Astir1 (stirrups area) = 78.53982
     psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
       Lstir2 (Length of stirrups along Y) = 768.00
       Astir2 (stirrups area) = 50.26548
     ----
     psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
     psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
       Lstir1 (Length of stirrups along X) = 1040.00
       Astir1 (stirrups area) = 78.53982
     psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
       Lstir2 (Length of stirrups along X) = 768.00
       Astir2 (stirrups area) = 50.26548

       Asec = 120000.00
       s1 = 100.00
       s2 = 250.00
     fywe1 = 781.25
     fywe2 = 625.00
     fce = 30.00
   From ((5.A5), TBDY), TBDY: cc = 0.002
     c = confinement factor = 1.00
y1 = 0.0025
sh1 = 0.008
ft1 = 886.7403
fy1 = 738.9503
su1 = 0.032
   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 = 1.00
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, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 738.9503
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 898.293
fy2 = 748.5775
su2 = 0.032
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 = 1.00
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, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 748.5775
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 894.3662
fyv = 745.3052
suv = 0.032
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 = 1.00
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, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.19082108
2 = Asl,com/(b*d)*(fs2/fc) = 0.37540035
v = Asl,mid/(b*d)*(fsv/fc) = 0.33973286
and confined core properties:
b = 360.00
d = 347.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.22424379
2 = Asl,com/(b*d)*(fs2/fc) = 0.44115251
v = Asl,mid/(b*d)*(fsv/fc) = 0.39923778
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
' satisfies Eq. (4.4)
--->

v < εs,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
 εcu (4.10) = 0.37716748
MRc (4.17) = 7.0585E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N, ω1, ω2, v normalised to bo*do, instead of b*d
  - γ - δ parameters of confined concrete, fcc, εcc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 ε*cu (4.11) = 0.4569298
MRo (4.18) = 6.0413E+008
--->
 φu = εcu (4.2) = 1.2613948E-005
Mu = MRo

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
 φu = 3.1475172E-005
Mu = 5.4612E+008
----
with full section properties:
 b = 200.00
 d = 367.00
 d' = 33.00
 v = 0.81862252
   N = 1.8026E+006
 fc = 30.00
  εco (5A.5, TBDY) = 0.002
 Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.00925707
   The Shear_factor is considered equal to 1 (pure moment strength)
   From (5.4b), TBDY: εcu = 0.00925707
     ωwe (5.4c) = 0.0207149
     αse ((5.4d), TBDY) = (αse1*Aext+αse2*Aint)/Asec = 0.33836562
        αse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
        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.

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Aconf,max1 = 89600.00 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 external perimeter hoops.
Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max1 by a length
equal to half the clear spacing between external hoops.
AnoConf1 = 43733.333 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
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,max2 = 45264.00 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 internal perimeter hoops.
Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 32309.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
Lstir1 (Length of stirrups along Y) = 1040.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
Lstir2 (Length of stirrups along Y) = 768.00
Astir2 (stirrups area) = 50.26548
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
Lstir1 (Length of stirrups along X) = 1040.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
Lstir2 (Length of stirrups along X) = 768.00
Astir2 (stirrups area) = 50.26548

Asec = 120000.00
s1 = 100.00
s2 = 250.00
fywe1 = 781.25
fywe2 = 625.00
fce = 30.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.0025
sh1 = 0.008
ft1 = 898.293
fy1 = 748.5775
su1 = 0.032
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 = 1.00
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, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 748.5775
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 886.7403
fy2 = 738.9503
su2 = 0.032

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 = 1.00
 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, ASCE 41-17.
 with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 738.9503
 with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
 yv = 0.0025
 shv = 0.008
 ftv = 894.3662
 fyv = 745.3052
 suv = 0.032
 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 = 1.00
 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, ASCE 41-17.
 with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
 with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.7508007
 2 = Asl,com/(b*d)*(fs2/fc) = 0.38164216
 v = Asl,mid/(b*d)*(fsv/fc) = 0.67946571
and confined core properties:
 b = 160.00
 d = 347.00
 d' = 13.00
 fcc (5A.2, TBDY) = 30.00
 cc (5A.5, TBDY) = 0.002
 c = confinement factor = 1.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.99259314
 2 = Asl,com/(b*d)*(fs2/fc) = 0.50454853
 v = Asl,mid/(b*d)*(fsv/fc) = 0.898285
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
 ' satisfies Eq. (4.4)
--->
v < s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is not satisfied
--->
 cu (4.11) = 0.80138156
MRc (4.18) = 5.4612E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
 - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
 - N, 1, 2, v normalised to bo*do, instead of b*d
 - - parameters of confined concrete, fcc, cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel

--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 *cu (4.11) = 0.80674817
MRo (4.18) = 2.8580E+008
MRo < 0.8*MRc
--->
 u =   cu (unconfined full section) = 3.1475172E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 339150.739

Calculation of Shear Strength at edge 1, Vr1 = 339150.739
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 339150.739
  knl = 1 (zero step-static loading)

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

    = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
    Mu = 6.7415E+007
    Vu = 3.6347847E-006
  d = 0.8*h = 320.00
  Nu = 1.8026E+006
  Ag = 80000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 471238.898
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 471238.898
  Vs,j1 = 157079.633 is calculated for section web jacket, with:
    d = 160.00
    Av = 157079.633
    fy = 625.00
    s = 100.00
  Vs,j1 is multiplied by   Col,j1 = 1.00
    s/d = 0.625
  Vs,j2 = 314159.265 is calculated for section flange jacket, with:
    d = 320.00
    Av = 157079.633
    fy = 625.00
    s = 100.00
  Vs,j2 is multiplied by   Col,j2 = 1.00
    s/d = 0.3125
  Vs,core = Vs,c1 + Vs,c2 = 0.00
  Vs,c1 = 0.00 is calculated for section web core, with:
    d = 80.00

Av = 100530.965
      fy = 500.00
      s = 250.00
    Vs,c1 is multiplied by   Col,c1 = 0.00
      s/d = 3.125
    Vs,c2 = 0.00 is calculated for section flange core, with:
      d = 240.00
      Av = 100530.965
      fy = 500.00
      s = 250.00
    Vs,c2 is multiplied by   Col,c2 = 0.00
      s/d = 1.04167
    Vf ((11-3)-(11.4), ACI 440) = 0.00
    From (11-11), ACI 440: Vs + Vf <= 212577.225
      bw = 200.00

Calculation of Shear Strength at edge 2, Vr2 = 339150.739
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 339150.739
  knl = 1 (zero step-static loading)

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

    = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
    Mu = 5.3429E+007
    Vu = 3.6347847E-006
  d = 0.8*h = 320.00
  Nu = 1.8026E+006
  Ag = 80000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 471238.898
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 471238.898
  Vs,j1 = 157079.633 is calculated for section web jacket, with:
      d = 160.00
      Av = 157079.633
      fy = 625.00
      s = 100.00
    Vs,j1 is multiplied by   Col,j1 = 1.00
      s/d = 0.625
    Vs,j2 = 314159.265 is calculated for section flange jacket, with:
      d = 320.00
      Av = 157079.633
      fy = 625.00
      s = 100.00
    Vs,j2 is multiplied by   Col,j2 = 1.00
      s/d = 0.3125
  Vs,core = Vs,c1 + Vs,c2 = 0.00
  Vs,c1 = 0.00 is calculated for section web core, with:
      d = 80.00
      Av = 100530.965
      fy = 500.00
      s = 250.00
    Vs,c1 is multiplied by   Col,c1 = 0.00
      s/d = 3.125
    Vs,c2 = 0.00 is calculated for section flange core, with:
      d = 240.00
      Av = 100530.965
      fy = 500.00
      s = 250.00
    Vs,c2 is multiplied by   Col,c2 = 0.00
      s/d = 1.04167
    Vf ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: Vs + Vf <= 212577.225
   bw = 200.00

End Of Calculation of Shear Capacity ratio for element: column JLC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column JLC1 of floor 1
At local axis: 3
Integration Section: (a)
Section Type: rcjlcs

Constant Properties

Knowledge Factor,   = 0.90
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 30.00
New material of Secondary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 18.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 500.00
Concrete Elasticity, Ec = 19940.411
Steel Elasticity, Es = 200000.00
Max Height, Hmax = 400.00
Min Height, Hmin = 200.00
Max Width, Wmax = 400.00
Min Width, Wmin = 200.00
Jacket Thickness, tj = 50.00
Cover Thickness, c = 15.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lb/ld>=1)
No FRP Wrapping

Stepwise Properties

Bending Moment, M = -3.0601E+008
Shear Force, V2 = -62256.122
Shear Force, V3 = -174.4443
Axial Force, F = -1.8013E+006
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 2161.416
    -Compression: Aslc = 3191.858
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 2208.54
    -Compression: Asl,com = 1137.257
        -Middle: Asl,mid = 2007.478
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten,jacket = 1746.726
    -Compression: Asl,com,jacket = 829.3805
        -Middle: Asl,mid,jacket = 1545.664
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten,core = 461.8141
    -Compression: Asl,com,core = 307.8761

     -Middle: Asl,mid,core = 461.8141
Mean Diameter of Tension Reinforcement, DbL = 16.60

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $\theta u,R = *\theta u = 0.02990909$
 $\theta u = \theta y + \theta p = 0.03323232$

 - Calculation of θy -

 $\theta y = (My*Ls/3)/Eleff = 0.02052718$ ((4.29),Biskinis Phd))
 My = 3.1260E+008
 Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 4915.337
 From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 2.4951E+013
   factor = 0.70
    Ag = 120000.00
    Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00
    N = 1.8013E+006
   Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.5645E+013

Calculation of Yielding Moment My

Calculation of θy and My according to Annex 7 -

 $\phi y = Min(\phi y\_ten, \phi y\_com)$
 $\phi y\_ten = 1.9273633E-005$
 with fy = 596.2441
   d = 367.00
    $\xi y = 0.57853212$
   A = 0.11409279
   B = 0.08754673
    with pt = 0.0300891
      pc = 0.01549396
      pv = 0.02734983
      N = 1.8013E+006
      b = 200.00
       " = 0.08991826
 $\phi y\_comp = 7.6802956E-006$
 with fc = 30.00
   Ec = 25742.96
    $\xi y = 0.74420275$
   A = 0.01443594
   B = 0.04638683
    with Es = 200000.00

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

 - Calculation of θp -

From table 10-8: $\theta p = 0.01270514$
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
 shear control ratio VyE/VCol0E = 1.18753
 d = d_external = 367.00
 s = s_external = 100.00
- $\rho t = \rho s1 + \rho s2 + 2*tf/bw*(ffe/fs) = 0.00809358$
 jacket: $\rho s1 = Av1*Lstir1/(s1*Ag) = 0.00680678$
    Av1 = 78.53982, is the area of every stirrup parallel to loading (shear) direction
    Lstir1 = 1040.00, is the total Length of all stirrups parallel to loading (shear) direction

s1 = 100.00
   core: s2 = Av2*Lstir2/(s2*Ag) = 0.0012868
        Av2 = 50.26548, is the area of every stirrup parallel to loading (shear) direction
        Lstir2 = 768.00, is the total Length of all stirrups parallel to loading (shear) direction
        s2 = 250.00
   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.
   For the normalisation fs of jacket is used.
    NUD = 1.8013E+006
    Ag = 120000.00
    f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 25.00
    fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein = 596.2441
    fytE = (fy_ext_Trans_Reinf* s1+fy_int_Trans_Reinf* s2)/(s1+ s2) = 605.1263
pl = Area_Tot_Long_Rein/(b*d) = 0.07293289
   b = 200.00
   d = 367.00
    f'cE = 25.00

End Of Calculation of Chord Rotation Capacity for element: column JLC1 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 50 and 51)

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (2)

Start Of Calculation of Shear Capacity for element: column JLC1 of floor 1

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

Constant Properties

Knowledge Factor, = 0.90
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 12.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 19940.411
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, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 30.00
New material: Steel Strength, fs = fsm = 625.00
Existing Column
Existing material: Concrete Strength, fc = fcm = 18.00
Existing material: Steel Strength, fs = fsm = 500.00
##
Max Height, Hmax = 400.00
Min Height, Hmin = 200.00
Max Width, Wmax = 400.00
Min Width, Wmin = 200.00
Jacket Thickness, tj = 50.00
Cover Thickness, c = 15.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min = lb/ld >=1)
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -3.0601E+008
Shear Force, Va = -62256.122
EDGE -B-
Bending Moment, Mb = -6.5602E+007
Shear Force, Vb = 62256.122
BOTH EDGES
Axial Force, F = -1.8013E+006
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 5353.274
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1137.257
     -Compression: Asl,com = 2208.54
         -Middle: Asl,mid = 2007.478
Mean Diameter of Tension Reinforcement, DbL,ten = 16.80

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = *Vn = 280056.413
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 311173.792
  VCol = 311173.792
  knl = 1.00
    displacement_ductility_demand = 0.33443454

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

    = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 16.66667, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 3.29297
    Mu = 6.5602E+007
    Vu = 62256.122
  d = 0.8*h = 320.00
  Nu = 1.8013E+006
  Ag = 80000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 376991.118
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 376991.118
  Vs,j1 = 125663.706 is calculated for section web jacket, with:
    d = 160.00
    Av = 157079.633
    fy = 500.00
    s = 100.00
  Vs,j1 is multiplied by Col,j1 = 1.00
    s/d = 0.625
  Vs,j2 = 251327.412 is calculated for section flange jacket, with:
    d = 320.00
    Av = 157079.633
    fy = 500.00
    s = 100.00
  Vs,j2 is multiplied by Col,j2 = 1.00
    s/d = 0.3125
  Vs,core = Vs,c1 + Vs,c2 = 0.00
  Vs,c1 = 0.00 is calculated for section web core, with:
    d = 80.00
    Av = 100530.965
    fy = 400.00
    s = 250.00
  Vs,c1 is multiplied by Col,c1 = 0.00
    s/d = 3.125
  Vs,c2 = 0.00 is calculated for section flange core, with:
    d = 240.00
    Av = 100530.965
    fy = 400.00
    s = 250.00
  Vs,c2 is multiplied by Col,c2 = 0.00
    s/d = 1.04167
  Vf ((11-3)-(11.4), ACI 440) = 0.00
  From (11-11), ACI 440: Vs + Vf <= 173568.578
    bw = 200.00

----
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 = 0.00248037
 y = (My*Ls/3)/Eleff = 0.0074166 ((4.29),Biskinis Phd))
 My = 5.2685E+008
 Ls = M/V (with Ls > 0.1*L and Ls < 2*L) = 1053.751

From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 2.4951E+013
   factor = 0.70
    Ag = 120000.00
    Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00
    N = 1.8013E+006
   Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.5645E+013

Calculation of Yielding Moment My

Calculation of   y and My according to Annex 7   -

Assuming neutral axis within flange (y < t/d, compression zone rectangular) with:
flange width, b = 400.00
web width, bw = 200.00
flange thickness, t = 200.00
----
  y = Min(y_ten, y_com)
  y_ten = 1.4408661E-005
 with fy = 596.2441
   d = 367.00
    y = 0.43622678
   A = 0.05704639
   B = 0.03713198
    with pt = 0.00774698
      pc = 0.01504455
      pv = 0.01367492
      N = 1.8013E+006
      b = 400.00
       " = 0.08991826
  y_comp = 1.2585428E-005
 with fc = 30.00
   Ec = 25742.96
    y = 0.45415198
   A = 0.00721797
   B = 0.01655203
    with Es = 200000.00
CONFIRMATION: y = 0.45415198 < t/d

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

End Of Calculation of Shear Capacity for element: column JLC1 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 50 and 51)

Analysis: Uniform + X

Check: Chord rotation capacity (u)

Edge: End

Local Axis: (2)

Start Of Calculation of Shear Capacity ratio for element: column JLC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcjlcs

Constant Properties

Knowledge Factor,   = 0.90
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 30.00
New material of Secondary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 18.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 500.00
Concrete Elasticity, Ec = 19940.411
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
Jacket
New material: Steel Strength, fs = 1.25*fsm = 781.25
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 625.00
##
Max Height, Hmax = 400.00
Min Height, Hmin = 200.00
Max Width, Wmax = 400.00
Min Width, Wmin = 200.00
Jacket Thickness, tj = 50.00
Cover Thickness, c = 15.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel

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Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = 2.3476251E-006
EDGE -B-
Shear Force, Vb = -2.3476251E-006
BOTH EDGES
Axial Force, F = -1.8026E+006
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 5353.274
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 2208.54
     -Compression: Asl,com = 1137.257
         -Middle: Asl,mid = 2007.478

Calculation of Shear Capacity ratio , Ve/Vr = 1.44151
Member Controlled by Shear (Ve/Vr > 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 488890.189
with
Mpr1 = Max(Mu1+ , Mu1-) = 7.3334E+008
   Mu1+ = 7.3334E+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- = 6.3768E+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-) = 7.3334E+008
   Mu2+ = 7.3334E+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- = 6.3768E+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 = 4.2207094E-005
Mu = 7.3334E+008
----
with full section properties:
 b = 400.00
 d = 367.00
 d' = 33.00
 ν = 0.40931126
    N = 1.8026E+006
 fc = 30.00
  εco (5A.5, TBDY) = 0.002
 Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.00925707
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.00925707
      ωe (5.4c) = 0.0207149
       ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.33836562
          ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
          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,max1 = 89600.00 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 external perimeter hoops.
Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max1 by a length
equal to half the clear spacing between external hoops.
AnoConf1 = 43733.333 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
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,max2 = 45264.00 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 internal perimeter hoops.
Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 32309.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

    ----
        psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
            Lstir1 (Length of stirrups along Y) = 1040.00
            Astir1 (stirrups area) = 78.53982
        psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
            Lstir2 (Length of stirrups along Y) = 768.00
            Astir2 (stirrups area) = 50.26548

    ----
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
            Lstir1 (Length of stirrups along X) = 1040.00
            Astir1 (stirrups area) = 78.53982
        psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
            Lstir2 (Length of stirrups along X) = 768.00
            Astir2 (stirrups area) = 50.26548

        Asec = 120000.00
        s1 = 100.00
        s2 = 250.00
        fywe1 = 781.25
        fywe2 = 625.00
        fce = 30.00
    From ((5.A5), TBDY), TBDY: cc = 0.002
        c = confinement factor = 1.00
  y1 = 0.0025
  sh1 = 0.008
 ft1 = 898.293
 fy1 = 748.5775
  su1 = 0.032
    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 = 1.00
    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, ASCE 41-17.
    with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 748.5775
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.0025
  sh2 = 0.008
 ft2 = 886.7403

fy2 = 738.9503
  su2 = 0.032
   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 = 1.00
    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, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 738.9503
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.0025
  shv = 0.008
 ftv = 894.3662
 fyv = 745.3052
  suv = 0.032
   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 = 1.00
    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, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.37540035
  2 = Asl,com/(b*d)*(fs2/fc) = 0.19082108
  v = Asl,mid/(b*d)*(fsv/fc) = 0.33973286
and confined core properties:
  b = 360.00
  d = 347.00
  d' = 13.00
  fcc (5A.2, TBDY) = 30.00
  cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.44115251
   2 = Asl,com/(b*d)*(fs2/fc) = 0.22424379
   v = Asl,mid/(b*d)*(fsv/fc) = 0.39923778
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
 ' satisfies Eq. (4.4)
--->
v <　s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
 cu (4.10) = 0.59761571
MRc (4.17) = 7.3334E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N,　1,　2,　v normalised to bo*do, instead of b*d
  -　- parameters of confined concrete, fcc,　cc, used in lieu of fc, ecu

--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 *cu (4.11) = 0.62879536
MRo (4.18) = 4.5866E+008
MRo < 0.8*MRc
--->
 u = cu (unconfined full section) = 4.2207094E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 u = 4.8346386E-005
Mu = 6.3768E+008
----
with full section properties:
 b = 200.00
 d = 367.00
 d' = 33.00
 v = 0.81862252
   N = 1.8026E+006
 fc = 30.00
  co (5A.5, TBDY) = 0.002
 Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00925707
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00925707
      we (5.4c) = 0.0207149
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.33836562
         ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
         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,max1 = 89600.00 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 external perimeter hoops.
         Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
                 is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                 equal to half the clear spacing between external hoops.
         AnoConf1 = 43733.333 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
        ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
         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,max2 = 45264.00 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 internal perimeter hoops.
Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
    is calculated by reducing all the dimensions of the area Aconf,max2 by a length
    equal to half the clear spacing between internal hoops.
AnoConf2 = 32309.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
    Lstir1 (Length of stirrups along Y) = 1040.00
    Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
    Lstir2 (Length of stirrups along Y) = 768.00
    Astir2 (stirrups area) = 50.26548

----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
    Lstir1 (Length of stirrups along X) = 1040.00
    Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
    Lstir2 (Length of stirrups along X) = 768.00
    Astir2 (stirrups area) = 50.26548

Asec = 120000.00
s1 = 100.00
s2 = 250.00
fywe1 = 781.25
fywe2 = 625.00
fce = 30.00
From ((5.A5), TBDY), TBDY: cc = 0.002
    c = confinement factor = 1.00
y1 = 0.0025
sh1 = 0.008
ft1 = 886.7403
fy1 = 738.9503
su1 = 0.032
    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 = 1.00
    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, ASCE 41-17.
    with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 738.9503
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 898.293
fy2 = 748.5775
su2 = 0.032
    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 = 1.00
    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, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 748.5775
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.0025
shv = 0.008
ftv = 894.3662
fyv = 745.3052
suv = 0.032
    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 = 1.00
    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, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.38164216
2 = Asl,com/(b*d)*(fs2/fc) = 0.7508007
v = Asl,mid/(b*d)*(fsv/fc) = 0.67946571
and confined core properties:
  b = 160.00
  d = 347.00
  d' = 13.00
  fcc (5A.2, TBDY) = 30.00
  cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.50454853
    2 = Asl,com/(b*d)*(fs2/fc) = 0.99259314
    v = Asl,mid/(b*d)*(fsv/fc) = 0.898285
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
  ' satisfies Eq. (4.4)
--->
v <   s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
 cu (4.10) = 0.52172715
MRc (4.17) = 6.3768E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N,   1,   2,   v normalised to bo*do, instead of b*d
  -   - parameters of confined concrete, fcc,   cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->

v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 *cu (4.11) = 0.5604845
MRo (4.18) = 4.7738E+008
MRo < 0.8*MRc
--->
 u =   cu (unconfined full section) = 4.8346386E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
 u = 4.2207094E-005
Mu = 7.3334E+008
----
with full section properties:
 b = 400.00
 d = 367.00
 d' = 33.00
 v = 0.40931126
   N = 1.8026E+006
 fc = 30.00
  co (5A.5, TBDY) = 0.002
 Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00925707
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00925707
      we (5.4c) = 0.0207149
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.33836562
        ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
        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,max1 = 89600.00 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 external perimeter hoops.
        Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
                is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                equal to half the clear spacing between external hoops.
        AnoConf1 = 43733.333 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
      ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
        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,max2 = 45264.00 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 internal perimeter hoops.
        Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
                is calculated by reducing all the dimensions of the area Aconf,max2 by a length
                equal to half the clear spacing between internal hoops.
        AnoConf2 = 32309.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
      psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
    Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
        ----
        psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678

```
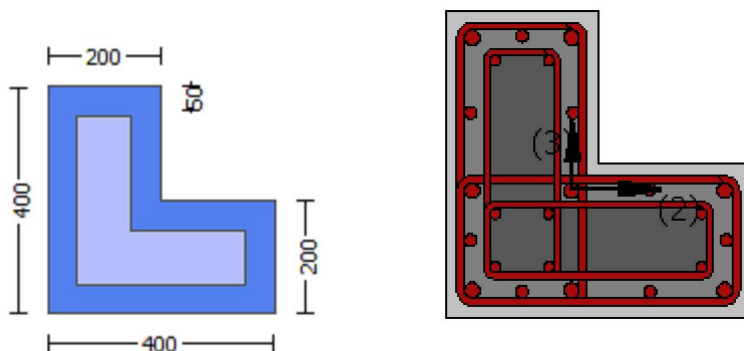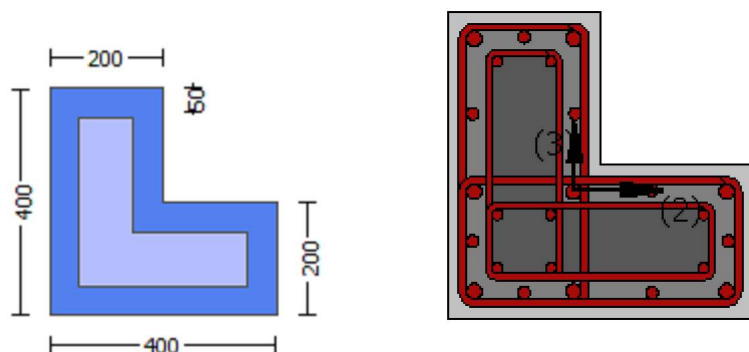        Lstir1 (Length of stirrups along Y) = 1040.00
        Astir1 (stirrups area) = 78.53982
     psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
        Lstir2 (Length of stirrups along Y) = 768.00
        Astir2 (stirrups area) = 50.26548
     -------------------------------------------------------------
     psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
     psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
        Lstir1 (Length of stirrups along X) = 1040.00
        Astir1 (stirrups area) = 78.53982
     psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
        Lstir2 (Length of stirrups along X) = 768.00
        Astir2 (stirrups area) = 50.26548
     -------------------------------------------------------------
        Asec = 120000.00
        s1 = 100.00
        s2 = 250.00
     fywe1 = 781.25
     fywe2 = 625.00
     fce  = 30.00
  From ((5.A5), TBDY), TBDY:  cc = 0.002
        c  = confinement factor = 1.00
 y1 = 0.0025
 sh1 = 0.008
ft1 = 898.293
fy1 = 748.5775
 su1 = 0.032
   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 = 1.00
    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, ASCE 41-17.
     with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 748.5775
     with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
 y2 = 0.0025
 sh2 = 0.008
ft2 = 886.7403
fy2 = 738.9503
 su2 = 0.032
   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 = 1.00
    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, ASCE 41-17.
     with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 738.9503
     with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
 yv = 0.0025
 shv = 0.008
ftv = 894.3662
fyv = 745.3052
 suv = 0.032
   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 = 1.00
    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, ASCE 41-17.
   with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
   with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.37540035
  2 = Asl,com/(b*d)*(fs2/fc) = 0.19082108
  v = Asl,mid/(b*d)*(fsv/fc) = 0.33973286
and confined core properties:
  b = 360.00
  d = 347.00
  d' = 13.00
  fcc (5A.2, TBDY) = 30.00
   cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.44115251
  2 = Asl,com/(b*d)*(fs2/fc) = 0.22424379
  v = Asl,mid/(b*d)*(fsv/fc) = 0.39923778
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
  ' satisfies Eq. (4.4)
--->
v <   s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
 cu (4.10) = 0.59761571
MRc (4.17) = 7.3334E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N,   1,   2,   v normalised to bo*do, instead of b*d
  -   -   parameters of confined concrete, fcc,   cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 *cu (4.11) = 0.62879536
MRo (4.18) = 4.5866E+008
MRo < 0.8*MRc
--->
 u =   cu (unconfined full section) = 4.2207094E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 4.8346386E-005
Mu = 6.3768E+008
----

with full section properties:
  b = 200.00
  d = 367.00
  d' = 33.00
  ν = 0.81862252
    N = 1.8026E+006
  fc = 30.00
   εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.00925707
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: εcu = 0.00925707
       ωwe (5.4c) = 0.0207149
       αse ((5.4d), TBDY) = (αse1*Aext+αse2*Aint)/Asec = 0.33836562
         αse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
         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,max1 = 89600.00 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 external perimeter hoops.
         Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
               is calculated by reducing all the dimensions of the area Aconf,max1 by a length
               equal to half the clear spacing between external hoops.
         AnoConf1 = 43733.333 is the unconfined external core area which is equal to Σbi2/6 as defined at (A.2).
       αse2 (>=αse1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
         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,max2 = 45264.00 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 internal perimeter hoops.
         Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
               is calculated by reducing all the dimensions of the area Aconf,max2 by a length
               equal to half the clear spacing between internal hoops.
         AnoConf2 = 32309.333 is the unconfined internal core area which is equal to Σbi2/6 as defined at (A.2).
       ρsh,min*Fywe = Min(ρsh,x*Fywe , ρsh,y*Fywe) = 6.12205
     Expression (5.4d) for ρsh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

         ρsh_x*Fywe = ρsh1*Fywe1+ρs2*Fywe2 = 6.12205
         ρsh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
           Lstir1 (Length of stirrups along Y) = 1040.00
           Astir1 (stirrups area) = 78.53982
         ρsh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
           Lstir2 (Length of stirrups along Y) = 768.00
           Astir2 (stirrups area) = 50.26548

         ρsh_y*Fywe = ρsh1*Fywe1+ρs2*Fywe2 = 6.12205
         ρsh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
           Lstir1 (Length of stirrups along X) = 1040.00
           Astir1 (stirrups area) = 78.53982
         ρsh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
           Lstir2 (Length of stirrups along X) = 768.00
           Astir2 (stirrups area) = 50.26548

```
                    ------------------------------------------------------------------------
                          Asec = 120000.00
                            s1 = 100.00
                            s2 = 250.00
                        fywe1 = 781.25
                        fywe2 = 625.00
                          fce = 30.00
                      From ((5.A5), TBDY),  TBDY:  cc = 0.002
                          c = confinement factor = 1.00
             y1 = 0.0025
            sh1 = 0.008
          ft1 = 886.7403
          fy1 = 738.9503
            su1 = 0.032
              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 = 1.00
                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, ASCE 41-17.
                with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 738.9503
                with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
             y2 = 0.0025
            sh2 = 0.008
          ft2 = 898.293
          fy2 = 748.5775
            su2 = 0.032
              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 = 1.00
                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, ASCE 41-17.
                with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 748.5775
                with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
            yv = 0.0025
            shv = 0.008
          ftv = 894.3662
          fyv = 745.3052
            suv = 0.032
              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 = 1.00
                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, ASCE 41-17.
                with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
                with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
              1 = Asl,ten/(b*d)*(fs1/fc) = 0.38164216
              2 = Asl,com/(b*d)*(fs2/fc) = 0.7508007
              v = Asl,mid/(b*d)*(fsv/fc) = 0.67946571
 and confined core properties:
            b = 160.00
            d = 347.00
            d' = 13.00
          fcc (5A.2, TBDY) = 30.00
            cc (5A.5, TBDY) = 0.002
```

c = confinement factor = 1.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.50454853
   2 = Asl,com/(b*d)*(fs2/fc) = 0.99259314
   v = Asl,mid/(b*d)*(fsv/fc) = 0.898285
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
  ' satisfies Eq. (4.4)
--->
v <   s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
  cu (4.10) = 0.52172715
MRc (4.17) = 6.3768E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N,   1,   2,   v normalised to bo*do, instead of b*d
  -   -   parameters of confined concrete, fcc,   cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
  *cu (4.11) = 0.5604845
MRo (4.18) = 4.7738E+008
MRo < 0.8*MRc
--->
  u =   cu (unconfined full section) = 4.8346386E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 339150.739

Calculation of Shear Strength at edge 1, Vr1 = 339150.739
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
   VCol0 = 339150.739
   knl = 1 (zero step-static loading)

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

    = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
    Mu = 2.0345E+006
    Vu = 2.3476251E-006
  d = 0.8*h = 320.00
  Nu = 1.8026E+006
  Ag = 80000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 471238.898
  where:
 Vs,jacket = Vs,j1 + Vs,j2 = 471238.898
 Vs,j1 = 314159.265 is calculated for section web jacket, with:
   d = 320.00
   Av = 157079.633
   fy = 625.00
   s = 100.00
 Vs,j1 is multiplied by Col,j1 = 1.00
   s/d = 0.3125
 Vs,j2 = 157079.633 is calculated for section flange jacket, with:
   d = 160.00
   Av = 157079.633
   fy = 625.00
   s = 100.00
 Vs,j2 is multiplied by Col,j2 = 1.00
   s/d = 0.625
 Vs,core = Vs,c1 + Vs,c2 = 0.00
 Vs,c1 = 0.00 is calculated for section web core, with:
   d = 240.00
   Av = 100530.965
   fy = 500.00
   s = 250.00
 Vs,c1 is multiplied by Col,c1 = 0.00
   s/d = 1.04167
 Vs,c2 = 0.00 is calculated for section flange core, with:
   d = 80.00
   Av = 100530.965
   fy = 500.00
   s = 250.00
 Vs,c2 is multiplied by Col,c2 = 0.00
   s/d = 3.125
 Vf ((11-3)-(11.4), ACI 440) = 0.00
 From (11-11), ACI 440: Vs + Vf <= 212577.225
  bw = 200.00

Calculation of Shear Strength at edge 2, Vr2 = 339150.739
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
 VCol0 = 339150.739
 knl = 1 (zero step-static loading)

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

    = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
    Mu = 6739.685
    Vu = 2.3476251E-006
  d = 0.8*h = 320.00
  Nu = 1.8026E+006
  Ag = 80000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 471238.898
  where:
 Vs,jacket = Vs,j1 + Vs,j2 = 471238.898

Vs,j1 = 314159.265 is calculated for section web jacket, with:
  d = 320.00
  Av = 157079.633
  fy = 625.00
  s = 100.00
Vs,j1 is multiplied by   Col,j1 = 1.00
  s/d = 0.3125
Vs,j2 = 157079.633 is calculated for section flange jacket, with:
  d = 160.00
  Av = 157079.633
  fy = 625.00
  s = 100.00
Vs,j2 is multiplied by   Col,j2 = 1.00
  s/d = 0.625
Vs,core = Vs,c1 + Vs,c2 = 0.00
Vs,c1 = 0.00 is calculated for section web core, with:
  d = 240.00
  Av = 100530.965
  fy = 500.00
  s = 250.00
Vs,c1 is multiplied by   Col,c1 = 0.00
  s/d = 1.04167
Vs,c2 = 0.00 is calculated for section flange core, with:
  d = 80.00
  Av = 100530.965
  fy = 500.00
  s = 250.00
Vs,c2 is multiplied by   Col,c2 = 0.00
  s/d = 3.125
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 212577.225
  bw = 200.00

End Of Calculation of Shear Capacity ratio for element: column JLC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column JLC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjlcs

Constant Properties

Knowledge Factor,   = 0.90
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 30.00
New material of Secondary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 18.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 500.00
Concrete Elasticity, Ec = 19940.411
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
Jacket
New material: Steel Strength, fs = 1.25*fsm = 781.25
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 625.00

```
###########################################################
Max Height, Hmax = 400.00
Min Height, Hmin = 200.00
Max Width, Wmax = 400.00
Min Width, Wmin = 200.00
Jacket Thickness, tj = 50.00
Cover Thickness, c = 15.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
No FRP Wrapping
------------------------------------------------------------

Stepwise Properties
------------------------------------------------------------
At local axis: 2
EDGE -A-
Shear Force, Va = -3.6347847E-006
EDGE -B-
Shear Force, Vb = 3.6347847E-006
BOTH EDGES
Axial Force, F = -1.8026E+006
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
    -Compression: Aslc = 5353.274
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 1137.257
    -Compression: Asl,com = 2208.54
      -Middle: Asl,mid = 2007.478
------------------------------------------------------------
------------------------------------------------------------


Calculation of Shear Capacity ratio , Ve/Vr  =  1.18753
Member Controlled by Shear (Ve/Vr > 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 402750.026
with
Mpr1 =  Max(Mu1+ , Mu1-) = 6.0413E+008
   Mu1+ = 6.0413E+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- = 5.4612E+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-) = 6.0413E+008
   Mu2+ = 6.0413E+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- = 5.4612E+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 = 1.2613948E-005
Mu = 6.0413E+008
-------------------------------------------------------------------
with full section properties:
  b = 400.00
  d = 367.00
  d' = 33.00
  v = 0.40931126
```

N = 1.8026E+006
fc = 30.00
 co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00925707
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00925707
      we (5.4c) = 0.0207149
       ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.33836562
          ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
          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,max1 = 89600.00 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 external perimeter hoops.
          Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
                 is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                 equal to half the clear spacing between external hoops.
          AnoConf1 = 43733.333 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
        ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
          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,max2 = 45264.00 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 internal perimeter hoops.
          Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
                 is calculated by reducing all the dimensions of the area Aconf,max2 by a length
                 equal to half the clear spacing between internal hoops.
          AnoConf2 = 32309.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
        psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
    Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
      ----
      psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
      psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
        Lstir1 (Length of stirrups along Y) = 1040.00
        Astir1 (stirrups area) = 78.53982
      psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
        Lstir2 (Length of stirrups along Y) = 768.00
        Astir2 (stirrups area) = 50.26548
      ----
      psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
      psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
        Lstir1 (Length of stirrups along X) = 1040.00
        Astir1 (stirrups area) = 78.53982
      psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
        Lstir2 (Length of stirrups along X) = 768.00
        Astir2 (stirrups area) = 50.26548

        Asec = 120000.00
        s1 = 100.00
        s2 = 250.00
      fywe1 = 781.25
      fywe2 = 625.00
      fce = 30.00
    From ((5.A5), TBDY), TBDY: cc = 0.002
        c = confinement factor = 1.00
  y1 = 0.0025
  sh1 = 0.008
 ft1 = 886.7403
 fy1 = 738.9503
  su1 = 0.032
    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 = 1.00
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, ASCE 41-17.
  with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 738.9503
  with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 898.293
fy2 = 748.5775
su2 = 0.032
  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 = 1.00
  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, ASCE 41-17.
  with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 748.5775
  with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 894.3662
fyv = 745.3052
suv = 0.032
  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 = 1.00
  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, ASCE 41-17.
  with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.19082108
2 = Asl,com/(b*d)*(fs2/fc) = 0.37540035
v = Asl,mid/(b*d)*(fsv/fc) = 0.33973286
and confined core properties:
b = 360.00
d = 347.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
  c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.22424379
2 = Asl,com/(b*d)*(fs2/fc) = 0.44115251
v = Asl,mid/(b*d)*(fsv/fc) = 0.39923778
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
' satisfies Eq. (4.4)
--->

ε < εs,y1 - LHS eq.(4.7) is not satisfied
--->
ε < εvc,y1 - RHS eq.(4.6) is satisfied
--->
 ξcu (4.10) = 0.37716748
MRc (4.17) = 7.0585E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N, ω1, ω2, ν normalised to bo*do, instead of b*d
  - ε - parameters of confined concrete, fcc, εcc, used in lieu of fc, εcu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 ξ*cu (4.11) = 0.4569298
MRo (4.18) = 6.0413E+008
--->
 φu = εcu (4.2) = 1.2613948E-005
Mu = MRo

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
 φu = 3.1475172E-005
Mu = 5.4612E+008
----
with full section properties:
 b = 200.00
 d = 367.00
 d' = 33.00
 v = 0.81862252
   N = 1.8026E+006
 fc = 30.00
  εco (5A.5, TBDY) = 0.002
 Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.00925707
   The Shear_factor is considered equal to 1 (pure moment strength)
   From (5.4b), TBDY: εcu = 0.00925707
     ωwe (5.4c) = 0.0207149
     αse ((5.4d), TBDY) = (αse1*Aext+αse2*Aint)/Asec = 0.33836562
       αse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
       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,max1 = 89600.00 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 external perimeter hoops.
Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
        is calculated by reducing all the dimensions of the area Aconf,max1 by a length
        equal to half the clear spacing between external hoops.
AnoConf1 = 43733.333 is the unconfined external core area which is equal to   bi2/6 as defined at (A.2).
ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
        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,max2 = 45264.00 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 internal perimeter hoops.
Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
        is calculated by reducing all the dimensions of the area Aconf,max2 by a length
        equal to half the clear spacing between internal hoops.
AnoConf2 = 32309.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205

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

----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
    Lstir1 (Length of stirrups along Y) = 1040.00
    Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
    Lstir2 (Length of stirrups along Y) = 768.00
    Astir2 (stirrups area) = 50.26548
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
    Lstir1 (Length of stirrups along X) = 1040.00
    Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
    Lstir2 (Length of stirrups along X) = 768.00
    Astir2 (stirrups area) = 50.26548

Asec = 120000.00
s1 = 100.00
s2 = 250.00
fywe1 = 781.25
fywe2 = 625.00
fce = 30.00
From ((5.A5), TBDY), TBDY: cc = 0.002
    c = confinement factor = 1.00
y1 = 0.0025
sh1 = 0.008
ft1 = 898.293
fy1 = 748.5775
su1 = 0.032
    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 = 1.00
    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, ASCE 41-17.
    with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 748.5775
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 886.7403
fy2 = 738.9503
su2 = 0.032

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 = 1.00
 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, ASCE 41-17.
 with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 738.9503
 with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
 yv = 0.0025
 shv = 0.008
 ftv = 894.3662
 fyv = 745.3052
 suv = 0.032
 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 = 1.00
  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, ASCE 41-17.
 with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
 with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.7508007
 2 = Asl,com/(b*d)*(fs2/fc) = 0.38164216
 v = Asl,mid/(b*d)*(fsv/fc) = 0.67946571
and confined core properties:
 b = 160.00
 d = 347.00
 d' = 13.00
 fcc (5A.2, TBDY) = 30.00
  cc (5A.5, TBDY) = 0.002
   c = confinement factor = 1.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.99259314
 2 = Asl,com/(b*d)*(fs2/fc) = 0.50454853
 v = Asl,mid/(b*d)*(fsv/fc) = 0.898285
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
 ' satisfies Eq. (4.4)
--->
v < s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is not satisfied
--->
 cu (4.11) = 0.80138156
MRc (4.18) = 5.4612E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
 - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
 - N, 1, 2, v normalised to bo*do, instead of b*d
 - - parameters of confined concrete, fcc, cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel

--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->
 *cu (4.11) = 0.80674817
MRo (4.18) = 2.8580E+008
MRo < 0.8*MRc
--->
 u = cu (unconfined full section) = 3.1475172E-005
Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.2613948E-005
Mu = 6.0413E+008
----
with full section properties:
  b = 400.00
  d = 367.00
  d' = 33.00
  v = 0.40931126
    N = 1.8026E+006
  fc = 30.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00925707
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.00925707
      we (5.4c) = 0.0207149
       ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.33836562
          ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
          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,max1 = 89600.00 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 external perimeter hoops.
          Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
                  is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                  equal to half the clear spacing between external hoops.
          AnoConf1 = 43733.333 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
        ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
          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,max2 = 45264.00 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 internal perimeter hoops.
Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 32309.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

----

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
   Lstir1 (Length of stirrups along Y) = 1040.00
   Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
   Lstir2 (Length of stirrups along Y) = 768.00
   Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
   Lstir1 (Length of stirrups along X) = 1040.00
   Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
   Lstir2 (Length of stirrups along X) = 768.00
   Astir2 (stirrups area) = 50.26548

   Asec = 120000.00
   s1 = 100.00
   s2 = 250.00
   fywe1 = 781.25
   fywe2 = 625.00
   fce = 30.00
From ((5.A5), TBDY), TBDY: cc = 0.002
   c = confinement factor = 1.00
y1 = 0.0025
sh1 = 0.008
ft1 = 886.7403
fy1 = 738.9503
su1 = 0.032
   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 = 1.00
    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, ASCE 41-17.
    with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 738.9503
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 898.293
fy2 = 748.5775
su2 = 0.032
   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 = 1.00
    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, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 748.5775
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008

ftv = 894.3662
fyv = 745.3052
 suv = 0.032
  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 = 1.00
   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, ASCE 41-17.
   with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
   with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.19082108
  2 = Asl,com/(b*d)*(fs2/fc) = 0.37540035
  v = Asl,mid/(b*d)*(fsv/fc) = 0.33973286
and confined core properties:
  b = 360.00
  d = 347.00
  d' = 13.00
  fcc (5A.2, TBDY) = 30.00
   cc (5A.5, TBDY) = 0.002
     c = confinement factor = 1.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.22424379
  2 = Asl,com/(b*d)*(fs2/fc) = 0.44115251
  v = Asl,mid/(b*d)*(fsv/fc) = 0.39923778
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 not satisfied
--->
Case/Assumption Rejected.
--->
New Case/Assumption: Unconfinesd full section - Spalling of concrete cover
 ' satisfies Eq. (4.4)
--->
v <   s,y1 - LHS eq.(4.7) is not satisfied
--->
v < vc,y1 - RHS eq.(4.6) is satisfied
--->
 cu (4.10) = 0.37716748
MRc (4.17) = 7.0585E+008
--->
New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover
In expressions below, the following modifications have been made
  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o
  - N,   1,   2, v normalised to bo*do, instead of b*d
  -   - parameters of confined concrete, fcc, cc, used in lieu of fc, ecu
--->
Subcase: Rupture of tension steel
--->
v* < v*s,y2 - LHS eq.(4.5) is not satisfied
--->
v* < v*s,c - LHS eq.(4.5) is not satisfied
--->
Subcase rejected
--->
New Subcase: Failure of compression zone
--->
v* < v*c,y2 - LHS eq.(4.6) is not satisfied
--->
v* < v*c,y1 - RHS eq.(4.6) is not satisfied
--->

```
 *cu (4.11) = 0.4569298
MRo (4.18) = 6.0413E+008
--->
  u =   cu (4.2) = 1.2613948E-005
Mu = MRo
----------------------------------------------------------

Calculation of ratio lb/ld
----------------------------------------------------------

Adequate Lap Length: lb/ld >= 1
-----------------------------------------------------------------------
-----------------------------------------------------------------------
-----------------------------------------------------------------------
Calculation of Mu2-
-----------------------------------------------------------------------

-----------------------------------------------------------------------
Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 3.1475172E-005
Mu = 5.4612E+008
-----------------------------------------------------------------------
with full section properties:
  b = 200.00
  d = 367.00
  d' = 33.00
  v = 0.81862252
    N = 1.8026E+006
  fc = 30.00
   co (5A.5, TBDY) = 0.002
  Final value of  cu:  cu* = shear_factor * Max( cu, cc) = 0.00925707
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY:  cu = 0.00925707
      we (5.4c) = 0.0207149
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.33836562
         ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.33836562
         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,max1 = 89600.00 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 external perimeter hoops.
         Aconf,min1 = 59225.00 is the confined core area at midway between the levels of hoops and
                 is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                 equal to half the clear spacing between external hoops.
         AnoConf1 = 43733.333 is the unconfined external core area which is equal to  bi2/6 as defined at (A.2).
       ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.33836562
         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,max2 = 45264.00 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 internal perimeter hoops.
         Aconf,min2 = 0.00 is the confined core area at midway between the levels of hoops and
                 is calculated by reducing all the dimensions of the area Aconf,max2 by a length
                 equal to half the clear spacing between internal hoops.
         AnoConf2 = 32309.333 is the unconfined internal core area which is equal to  bi2/6 as defined at (A.2).
       psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 6.12205
     Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
         ------------------------------------------------------------------
         psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
         psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
            Lstir1 (Length of stirrups along Y) = 1040.00
            Astir1 (stirrups area) = 78.53982
         psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.0012868
```

```
          Lstir2 (Length of stirrups along Y) = 768.00
          Astir2 (stirrups area) = 50.26548
     ------------------------------------------------------------------
       psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 6.12205
       psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00680678
          Lstir1 (Length of stirrups along X) = 1040.00
          Astir1 (stirrups area) = 78.53982
       psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.0012868
          Lstir2 (Length of stirrups along X) = 768.00
          Astir2 (stirrups area) = 50.26548
     ------------------------------------------------------------------
       Asec = 120000.00
       s1 = 100.00
       s2 = 250.00
     fywe1 = 781.25
     fywe2 = 625.00
      fce = 30.00
   From ((5.A5), TBDY), TBDY:  cc = 0.002
       c  = confinement factor = 1.00
 y1 = 0.0025
 sh1 = 0.008
ft1 = 898.293
fy1 = 748.5775
 su1 = 0.032
   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 = 1.00
    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, ASCE 41-17.
     with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 748.5775
     with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
 y2 = 0.0025
 sh2 = 0.008
ft2 = 886.7403
fy2 = 738.9503
 su2 = 0.032
   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 = 1.00
    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, ASCE 41-17.
     with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 738.9503
     with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
 yv = 0.0025
 shv = 0.008
ftv = 894.3662
fyv = 745.3052
 suv = 0.032
   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 = 1.00
    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, ASCE 41-17.
     with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 745.3052
```

with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00

ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.7508007

ω2 = Asl,com/(b*d)*(fs2/fc) = 0.38164216

ωv = Asl,mid/(b*d)*(fsv/fc) = 0.67946571

and confined core properties:

  b = 160.00

  d = 347.00

  d' = 13.00

  fcc (5A.2, TBDY) = 30.00

  εcc (5A.5, TBDY) = 0.002

    εc = confinement factor = 1.00

  ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.99259314

  ω2 = Asl,com/(b*d)*(fs2/fc) = 0.50454853

  ωv = Asl,mid/(b*d)*(fsv/fc) = 0.898285

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 not satisfied

--->

Case/Assumption Rejected.

--->

New Case/Assumption: Unconfinesd full section - Spalling of concrete cover

  ' satisfies Eq. (4.4)

--->

v < ωs,y1 - LHS eq.(4.7) is not satisfied

--->

v < vc,y1 - RHS eq.(4.6) is not satisfied

--->

ξcu (4.11) = 0.80138156

MRc (4.18) = 5.4612E+008

--->

New Case/Assumption: Ultimate curvature of confined core after spalling of concrete cover

In expressions below, the following modifications have been made

  - b, d, d' replaced by geometric parameters of the core: bo, do, d'o

  - N, ω1, ω2, ωv normalised to bo*do, instead of b*d

  - ε - parameters of confined concrete, fcc, εcc, used in lieu of fc, εcu

--->

Subcase: Rupture of tension steel

--->

v* < v*s,y2 - LHS eq.(4.5) is not satisfied

--->

v* < v*s,c - LHS eq.(4.5) is not satisfied

--->

Subcase rejected

--->

New Subcase: Failure of compression zone

--->

v* < v*c,y2 - LHS eq.(4.6) is not satisfied

--->

v* < v*c,y1 - RHS eq.(4.6) is not satisfied

--->

ξ*cu (4.11) = 0.80674817

MRo (4.18) = 2.8580E+008

MRo < 0.8*MRc

--->

φu = φcu (unconfined full section) = 3.1475172E-005

Mu = MRc

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

```
-------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 339150.739
-------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 339150.739
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 339150.739
  knl = 1 (zero step-static loading)
-------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+  f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
-------------------------------------------------------------
    = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
    Mu = 6.7415E+007
    Vu = 3.6347847E-006
  d = 0.8*h = 320.00
  Nu = 1.8026E+006
  Ag = 80000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 471238.898
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 471238.898
  Vs,j1 = 157079.633 is calculated for section web jacket, with:
    d = 160.00
    Av = 157079.633
    fy = 625.00
    s = 100.00
  Vs,j1 is multiplied by   Col,j1 = 1.00
    s/d = 0.625
  Vs,j2 = 314159.265 is calculated for section flange jacket, with:
    d = 320.00
    Av = 157079.633
    fy = 625.00
    s = 100.00
  Vs,j2 is multiplied by   Col,j2 = 1.00
    s/d = 0.3125
  Vs,core = Vs,c1 + Vs,c2 = 0.00
  Vs,c1 = 0.00 is calculated for section web core, with:
    d = 80.00
    Av = 100530.965
    fy = 500.00
    s = 250.00
  Vs,c1 is multiplied by   Col,c1 = 0.00
    s/d = 3.125
  Vs,c2 = 0.00 is calculated for section flange core, with:
    d = 240.00
    Av = 100530.965
    fy = 500.00
    s = 250.00
  Vs,c2 is multiplied by   Col,c2 = 0.00
    s/d = 1.04167
  Vf ((11-3)-(11.4), ACI 440) = 0.00
  From (11-11), ACI 440: Vs + Vf <= 212577.225
    bw = 200.00
-------------------------------------------------------------
-------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 339150.739
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 339150.739
  knl = 1 (zero step-static loading)
-------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+  f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
-------------------------------------------------------------
    = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3
```

MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
    Mu = 5.3429E+007
    Vu = 3.6347847E-006
  d = 0.8*h = 320.00
  Nu = 1.8026E+006
  Ag = 80000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 471238.898
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 471238.898
  Vs,j1 = 157079.633 is calculated for section web jacket, with:
    d = 160.00
    Av = 157079.633
    fy = 625.00
    s = 100.00
  Vs,j1 is multiplied by   Col,j1 = 1.00
    s/d = 0.625
  Vs,j2 = 314159.265 is calculated for section flange jacket, with:
    d = 320.00
    Av = 157079.633
    fy = 625.00
    s = 100.00
  Vs,j2 is multiplied by   Col,j2 = 1.00
    s/d = 0.3125
  Vs,core = Vs,c1 + Vs,c2 = 0.00
  Vs,c1 = 0.00 is calculated for section web core, with:
    d = 80.00
    Av = 100530.965
    fy = 500.00
    s = 250.00
  Vs,c1 is multiplied by   Col,c1 = 0.00
    s/d = 3.125
  Vs,c2 = 0.00 is calculated for section flange core, with:
    d = 240.00
    Av = 100530.965
    fy = 500.00
    s = 250.00
  Vs,c2 is multiplied by   Col,c2 = 0.00
    s/d = 1.04167
  Vf ((11-3)-(11.4), ACI 440) = 0.00
  From (11-11), ACI 440: Vs + Vf <= 212577.225
    bw = 200.00

End Of Calculation of Shear Capacity ratio for element: column JLC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column JLC1 of floor 1
At local axis: 2
Integration Section: (b)
Section Type: rcjlcs

Constant Properties

Knowledge Factor,   = 0.90
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 30.00
New material of Secondary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00
Existing Column

Existing material of Secondary Member: Concrete Strength, fc = fcm = 18.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 500.00
Concrete Elasticity, Ec = 19940.411
Steel Elasticity, Es = 200000.00
Max Height, Hmax = 400.00
Min Height, Hmin = 200.00
Max Width, Wmax = 400.00
Min Width, Wmin = 200.00
Jacket Thickness, tj = 50.00
Cover Thickness, c = 15.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lb/ld>=1)
No FRP Wrapping

Stepwise Properties

Bending Moment, M = 246078.073
Shear Force, V2 = 62256.122
Shear Force, V3 = 174.4443
Axial Force, F = -1.8013E+006
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 5353.274
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 2208.54
     -Compression: Asl,com = 1137.257
        -Middle: Asl,mid = 2007.478
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,jacket = 1746.726
     -Compression: Asl,com,jacket = 829.3805
        -Middle: Asl,mid,jacket = 1545.664
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,core = 461.8141
     -Compression: Asl,com,core = 307.8761
        -Middle: Asl,mid,core = 461.8141
Mean Diameter of Tension Reinforcement, DbL = 16.60

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity u,R =   * u = 0.02030057
 u = y + p = 0.02255618

 - Calculation of y -
----
 y = (My*Ls/3)/EIeff = 0.00985105 ((4.29),Biskinis Phd))
  My = 5.2274E+008
  Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1410.64
  From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 2.4951E+013
     factor = 0.70
        Ag = 120000.00
        Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00
        N = 1.8013E+006
     Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.5645E+013

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7   -

```
--------------------------------------------------------------
Assuming neutral axis out of flange ( y > t/d, compression zone NOT rectangular)
extended expressions (2.1)-(2.7) of Biskinis-Fardis (2009) are adopted with:
flange width, b = 400.00
web width, bw = 200.00
flange thickness, t = 200.00
--------------------------------------------------------------
  y = Min( y_ten, y_com)
  y_ten = 1.6046235E-005
 with fy = 596.2441
    d = 367.00
     y = 0.49376179
    A = 0.18423709
    B = 0.10665962
     with pt = 0.01504455
        pc = 0.00774698
        pv = 0.01367492
        N = 1.8013E+006
        b = 400.00
         " = 0.08991826
  y_comp = 1.0451884E-005
 with fc = 30.00
    Ec = 25742.96
     y = 0.54685808
    A = 0.08458025
    B = 0.06549972
     with Es = 200000.00
CONFIRMATION:  y = 0.54685808 > t/d
--------------------------------------------------------------

Calculation of ratio lb/ld
--------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1

--------------------------------------------------------------
 - Calculation of   p -
--------------------------------------------------------------
From table 10-8:   p = 0.01270514
with:
 - Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
  shear control ratio VyE/VColOE = 1.44151
  d = d_external = 367.00
  s = s_external = 100.00
 -  t =   s1 +   s2 + 2*tf/bw*(ffe/fs) = 0.00809358
  jacket:  s1 = Av1*Lstir1/(s1*Ag) = 0.00680678
      Av1 = 78.53982, is the area of every stirrup parallel to loading (shear) direction
      Lstir1 = 1040.00, is the total Length of all stirrups parallel to loading (shear) direction
      s1 = 100.00
  core:   s2 = Av2*Lstir2/(s2*Ag) = 0.0012868
      Av2 = 50.26548, is the area of every stirrup parallel to loading (shear) direction
      Lstir2 = 768.00, is the total Length of all stirrups parallel to loading (shear) direction
      s2 = 250.00
  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.
  For the normalisation fs of jacket is used.
   NUD = 1.8013E+006
   Ag = 120000.00
   f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 25.00
   fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein =
596.2441
   fytE = (fy_ext_Trans_Reinf*  s1+fy_int_Trans_Reinf*  s2)/(  s1+  s2) = 605.1263
pl = Area_Tot_Long_Rein/(b*d) = 0.03646644
  b = 400.00
  d = 367.00
   f'cE = 25.00
--------------------------------------------------------------
```

End Of Calculation of Chord Rotation Capacity for element: column JLC1 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 50 and 51)

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (3)

Start Of Calculation of Shear Capacity for element: column JLC1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rcjlcs

Constant Properties

Knowledge Factor,   = 0.90
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 20.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 12.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 19940.411
Steel Elasticity, Es = 200000.00

```
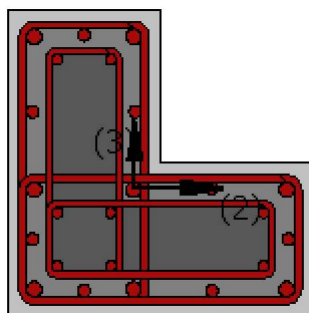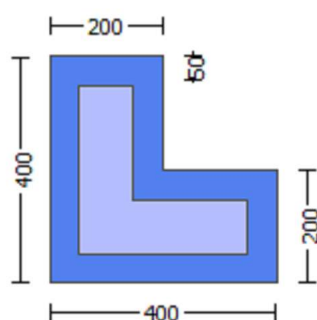############################################################
Note: Especially for the calculation of  y for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 30.00
New material: Steel Strength, fs = fsm = 625.00
Existing Column
Existing material: Concrete Strength, fc = fcm = 18.00
Existing material: Steel Strength, fs = fsm = 500.00
############################################################
Max Height, Hmax = 400.00
Min Height, Hmin = 200.00
Max Width, Wmax = 400.00
Min Width, Wmin = 200.00
Jacket Thickness, tj = 50.00
Cover Thickness, c = 15.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min = lb/ld >=1)
No FRP Wrapping
---------------------------------------------------------------

Stepwise Properties
---------------------------------------------------------------
EDGE -A-
Bending Moment, Ma = 1.1948E+007
Shear Force, Va = -174.4443
EDGE -B-
Bending Moment, Mb = 246078.073
Shear Force, Vb = 174.4443
BOTH EDGES
Axial Force, F = -1.8013E+006
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 5353.274
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 2208.54
     -Compression: Asl,com = 1137.257
         -Middle: Asl,mid = 2007.478
Mean Diameter of Tension Reinforcement, DbL,ten = 16.60
---------------------------------------------------------------
---------------------------------------------------------------


Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR =  *Vn = 258166.022
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 286851.135
   VCol = 286851.135
   knl = 1.00
      displacement_ductility_demand = 0.01679263
---------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+  f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
---------------------------------------------------------------
    = 1 (normal-weight concrete)
   Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 16.66667, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
   M/Vd = 4.00
      Mu = 246078.073
      Vu = 174.4443
   d = 0.8*h = 320.00
   Nu = 1.8013E+006
   Ag = 80000.00
```

From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 376991.118
  where:
 Vs,jacket = Vs,j1 + Vs,j2 = 376991.118
  Vs,j1 = 251327.412 is calculated for section web jacket, with:
    d = 320.00
    Av = 157079.633
    fy = 500.00
    s = 100.00
  Vs,j1 is multiplied by   Col,j1 = 1.00
    s/d = 0.3125
  Vs,j2 = 125663.706 is calculated for section flange jacket, with:
    d = 160.00
    Av = 157079.633
    fy = 500.00
    s = 100.00
  Vs,j2 is multiplied by   Col,j2 = 1.00
    s/d = 0.625
 Vs,core = Vs,c1 + Vs,c2 = 0.00
  Vs,c1 = 0.00 is calculated for section web core, with:
    d = 240.00
    Av = 100530.965
    fy = 400.00
    s = 250.00
  Vs,c1 is multiplied by   Col,c1 = 0.00
    s/d = 1.04167
  Vs,c2 = 0.00 is calculated for section flange core, with:
    d = 80.00
    Av = 100530.965
    fy = 400.00
    s = 250.00
  Vs,c2 is multiplied by   Col,c2 = 0.00
    s/d = 3.125
  Vf ((11-3)-(11.4), ACI 440) = 0.00
  From (11-11), ACI 440: Vs + Vf <= 173568.578
    bw = 200.00

----
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   = 0.00016542
  y = (My*Ls/3)/EIeff = 0.00985105 ((4.29),Biskinis Phd))
  My = 5.2274E+008
  Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1410.64
  From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 2.4951E+013
    factor = 0.70
      Ag = 120000.00
      Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00
      N = 1.8013E+006
    Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.5645E+013

Calculation of Yielding Moment My

Calculation of   y and My according to Annex 7   -

Assuming neutral axis out of flange (y > t/d, compression zone NOT rectangular)
extended expressions (2.1)-(2.7) of Biskinis-Fardis (2009) are adopted with:
flange width, b = 400.00
web width, bw = 200.00
flange thickness, t = 200.00
----
  y = Min(y_ten, y_com)

y_ten = 1.6046235E-005
with fy = 596.2441
    d = 367.00
    y = 0.49376179
    A = 0.18423709
    B = 0.10665962
    with pt = 0.01504455
        pc = 0.00774698
        pv = 0.01367492
        N = 1.8013E+006
        b = 400.00
        " = 0.08991826
  y_comp = 1.0451884E-005
with fc = 30.00
    Ec = 25742.96
    y = 0.54685808
    A = 0.08458025
    B = 0.06549972
    with Es = 200000.00
CONFIRMATION: y = 0.54685808 > t/d

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

End Of Calculation of Shear Capacity for element: column JLC1 of floor 1
At local axis: 3
Integration Section: (b)