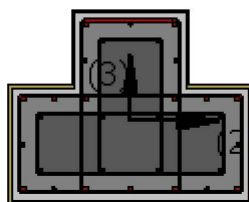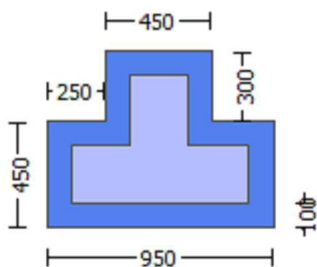# Detailed Member Calculations

Units: N&mm

Regulation: ASCE 41-17

Calculation No. 1

column C1, Floor 1

Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (2)

Start Of Calculation of Shear Capacity for element: column JTC1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rcjtcs

Constant Properties

Knowledge Factor,   = 0.80
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 Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00

Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
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 = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
##
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min =lb/ld = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -1.5449E+007
Shear Force, Va = -5103.636
EDGE -B-
Bending Moment, Mb = 135025.377
Shear Force, Vb = 5103.636
BOTH EDGES
Axial Force, F = -21366.38
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
    -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 1539.38
    -Compression: Asl,com = 1539.38
      -Middle: Asl,mid = 3612.832
Mean Diameter of Tension Reinforcement, DbL,ten = 16.57143

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 1.3528E+006
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 1.3528E+006
  VCol = 1.3528E+006
  knl = 1.00
    displacement_ductility_demand = 0.01353173

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 = 3.98294
    Mu = 1.5449E+007
    Vu = 5103.636
  d = 0.8*h = 760.00
  Nu = 21366.38
  Ag = 427500.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 1.0003E+006
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 879645.943
  Vs,j1 = 282743.339 is calculated for section web jacket, with:
    d = 360.00
    Av = 157079.633
    fy = 500.00
    s = 100.00
  Vs,j1 is multiplied by Col,j1 = 1.00
    s/d = 0.27777778
  Vs,j2 = 596902.604 is calculated for section flange jacket, with:
    d = 760.00
    Av = 157079.633
    fy = 500.00
    s = 100.00
  Vs,j2 is multiplied by Col,j2 = 1.00
    s/d = 0.13157895
  Vs,core = Vs,c1 + Vs,c2 = 120637.158
  Vs,c1 = 0.00 is calculated for section web core, with:
    d = 200.00
    Av = 100530.965
    fy = 500.00
    s = 250.00
  Vs,c1 is multiplied by Col,c1 = 0.00
    s/d = 1.25
  Vs,c2 = 120637.158 is calculated for section flange core, with:
    d = 600.00
    Av = 100530.965
    fy = 500.00
    s = 250.00
  Vs,c2 is multiplied by Col,c2 = 1.00
    s/d = 0.41666667
  Vf ((11-3)-(11.4), ACI 440) = 594992.00
    f = 0.95, for fully-wrapped sections
  wf/sf = 1 (FRP strips adjacent to one another).
  In (11.3) sin + cos is replaced with (cot +cota)sina which is more a generalised expression,
  where is the angle of the crack direction (see KANEPE).
  This later relation, considered as a function Vf(,), is implemented for every different fiber orientation ai,
  as well as for 2 crack directions, =45° and =-45° to take into consideration the cyclic seismic loading.
  orientation 1: 1 = b1 + 90° = 90.00
  Vf = Min(|Vf(45, 1)|,|Vf(-45,a1)|), with:
  total thickness per orientation, tf1 = NL*t/NoDir = 1.00
  dfv = d (figure 11.2, ACI 440) = 907.00
  ffe ((11-5), ACI 440) = 328.00
    Ef = 82000.00
    fe = 0.004, from (11.6a), ACI 440
      with fu = 0.009
  From (11-11), ACI 440: Vs + Vf <= 1.1360E+006
    bw = 450.00

----
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   = 3.3011991E-005
 y = (My*Ls/3)/Eleff = 0.0024396 ((4.29),Biskinis Phd))
  My = 6.7427E+008
  Ls = M/V (with Ls > 0.1*L and Ls < 2*L) = 3027.037
  From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 2.7887E+014
     factor = 0.30
        Ag = 562500.00
        Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
        N = 21366.38
     Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 9.2958E+014

Calculation of Yielding Moment My

Calculation of   y and My according to Annex 7   -
----
  y = Min(y_ten, y_com)
  y_ten = 2.3114142E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^ 2/3) = 311.2112
    d = 907.00
     y = 0.25776728
    A = 0.01656315
    B = 0.00875431
     with pt = 0.0037716
        pc = 0.0037716
        pv = 0.00885172
        N = 21366.38
        b = 450.00
         " = 0.04740904
  y_comp = 9.5688004E-006
 with fc* (12.3, (ACI 440)) = 33.31497
    fc = 33.00
    fl = 0.5419822
    b = bmax = 950.00
    h = hmax = 750.00
    Ag = 0.5625
        g = pt + pc + pv = 0.01639493
    rc = 40.00
    Ae/Ac = 0.29742395
    Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
   effective strain from (12.5) and (12.12), efe = 0.004
     fu = 0.009
    Ef = 82000.00
   Ec = 26999.444
    y = 0.25591301
   A = 0.01627709
   B = 0.0085861
    with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

End Of Calculation of Shear Capacity for element: column JTC1 of floor 1
At local axis: 2
Integration Section: (a)

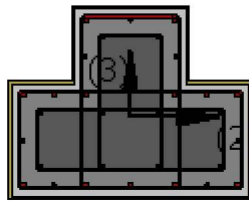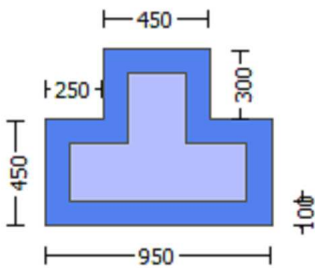
Calculation No. 2

column C1, Floor 1

Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (u)

Edge: Start

Local Axis: (2)

Start Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcjtcs

Constant Properties

Knowledge Factor,   = 0.80
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
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 = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45

```
##########################################################
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.02727
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi:  0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00
-------------------------------------------------------------

Stepwise Properties
-------------------------------------------------------------
At local axis: 3
EDGE -A-
Shear Force, Va = -2.5087409E-020
EDGE -B-
Shear Force, Vb = 2.5087409E-020
BOTH EDGES
Axial Force, F = -20792.022
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
    -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 1539.38
    -Compression: Asl,com = 2475.575
       -Middle: Asl,mid = 2676.637
-------------------------------------------------------------
-------------------------------------------------------------


Calculation of Shear Capacity ratio , Ve/Vr  =  0.44505685
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 632982.444
with
Mpr1 =  Max(Mu1+ , Mu1-) = 9.4947E+008
   Mu1+ = 6.7087E+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- = 9.4947E+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-) = 9.4947E+008
   Mu2+ = 6.7087E+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- = 9.4947E+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 = 8.5351751E-006
Mu = 6.7087E+008
----
with full section properties:
  b = 950.00
  d = 707.00
  d' = 43.00
  v = 0.00093808
    N = 20792.022
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.0116768
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+ Min(fx, fy) = 0.04178759
    where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----
      fx = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A4.4.3(6), pf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788
    ----
      fy = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A4.4.3(6), pf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788

      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
      fu,f = 840.00
      Ef = 82000.00
       u,f = 0.015
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
        ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
        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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
        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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00227274
c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139

suv = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.30
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esuv_nominal = 0.08,
   considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
   For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
   characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.02701806
   2 = Asl,com/(b*d)*(fs2/fc) = 0.04344945
   v = Asl,mid/(b*d)*(fsv/fc) = 0.04697834
and confined core properties:
  b = 890.00
  d = 677.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.90003
   cc (5A.5, TBDY) = 0.00227274
      c = confinement factor = 1.02727
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.03011747
    2 = Asl,com/(b*d)*(fs2/fc) = 0.04843381
    v = Asl,mid/(b*d)*(fsv/fc) = 0.05236752
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.15152684
Mu = MRc (4.14) = 6.7087E+008
  u =   su (4.1) = 8.5351751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 9.2428803E-006
Mu = 9.4947E+008
----
with full section properties:
  b = 450.00
  d = 707.00
  d' = 43.00
  v = 0.00198039
    N = 20792.022
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.0116768
     we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx,   fy) = 0.04178759
    where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----
     fx = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185

with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
   bmax = 950.00
   hmax = 750.00
   From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
     bw = 450.00
   effective stress from (A.35), ff,e = 773.4788
----
  fy = 0.02973616
Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
af = 0.28545185
with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
   bmax = 950.00
   hmax = 750.00
   From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
     bw = 450.00
   effective stress from (A.35), ff,e = 773.4788

  R = 40.00
  Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
  fu,f = 840.00
  Ef = 82000.00
  u,f = 0.015
  ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
    ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
    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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
    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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
   psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
    Lstir1 (Length of stirrups along Y) = 2160.00
    Astir1 (stirrups area) = 78.53982
   psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
    Lstir2 (Length of stirrups along Y) = 1568.00
    Astir2 (stirrups area) = 50.26548
----
   psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
   psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
    Lstir1 (Length of stirrups along X) = 2560.00
    Astir1 (stirrups area) = 78.53982
   psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
    Lstir2 (Length of stirrups along X) = 1968.00
    Astir2 (stirrups area) = 50.26548

Asec = 562500.00
                  s1 = 100.00
                  s2 = 250.00
              fywe1 = 694.45
              fywe2 = 694.45
                fce = 33.00
          From ((5.A.5), TBDY), TBDY: cc = 0.00227274
              c = confinement factor = 1.02727
      y1 = 0.00140044
      sh1 = 0.0044814
    ft1 = 466.8167
    fy1 = 389.0139
      su1 = 0.00512
        using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
        and also multiplied by the shear_factor according to 15.7.1.4, with
        Shear_factor = 1.00
        lo/lou,min = lb/ld = 0.30
          su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
        From table 5A.1, TBDY: esu1_nominal = 0.08,
        For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
        characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
          y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
          with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
          with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
      y2 = 0.00140044
      sh2 = 0.0044814
    ft2 = 466.8167
    fy2 = 389.0139
      su2 = 0.00512
        using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
        and also multiplied by the shear_factor according to 15.7.1.4, with
        Shear_factor = 1.00
        lo/lou,min = lb/lb,min = 0.30
          su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
        From table 5A.1, TBDY: esu2_nominal = 0.08,
        For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
        characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
          y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
          with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
          with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
      yv = 0.00140044
      shv = 0.0044814
    ftv = 466.8167
    fyv = 389.0139
      suv = 0.00512
        using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
        and also multiplied by the shear_factor according to 15.7.1.4, with
        Shear_factor = 1.00
        lo/lou,min = lb/ld = 0.30
          suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
        From table 5A.1, TBDY: esuv_nominal = 0.08,
        considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
        For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
        characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
          y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
          with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
          with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
      1 = Asl,ten/(b*d)*(fs1/fc) = 0.09172662
      2 = Asl,com/(b*d)*(fs2/fc) = 0.05703813
      v = Asl,mid/(b*d)*(fsv/fc) = 0.0991765
and confined core properties:
    b = 390.00
    d = 677.00
    d' = 13.00
    fcc (5A.2, TBDY) = 33.90003
      cc (5A.5, TBDY) = 0.00227274
          c = confinement factor = 1.02727

1 = Asl,ten/(b*d)*(fs1/fc) = 0.11052844
     2 = Asl,com/(b*d)*(fs2/fc) = 0.06872961
     v = Asl,mid/(b*d)*(fsv/fc) = 0.11950537
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.21649239
Mu = MRc (4.14) = 9.4947E+008
  u =   su (4.1) = 9.2428803E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 8.5351751E-006
Mu = 6.7087E+008
----
with full section properties:
  b = 950.00
  d = 707.00
  d' = 43.00
  v = 0.00093808
    N = 20792.022
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of   cu: cu* = shear_factor * Max(cu, cc) = 0.0116768
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: cu = 0.0116768
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx,   fy) = 0.04178759
     where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
     ----
      fx = 0.02973616
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
       bmax = 950.00
       hmax = 750.00
       From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
         bw = 450.00
       effective stress from (A.35), ff,e = 773.4788
     ----
      fy = 0.02973616
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
       bmax = 950.00
       hmax = 750.00
       From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
         bw = 450.00
       effective stress from (A.35), ff,e = 773.4788

       R = 40.00
       Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
       fu,f = 840.00
       Ef = 82000.00
        u,f = 0.015
       ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773

ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00227274
c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139

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

y2 = 0.00140044

sh2 = 0.0044814

ft2 = 466.8167

fy2 = 389.0139

su2 = 0.00512

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

   and also multiplied by the shear_factor according to 15.7.1.4, with

   Shear_factor = 1.00

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

   su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

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

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

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

   y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.

   with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139

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

yv = 0.00140044

shv = 0.0044814

ftv = 466.8167

fyv = 389.0139

suv = 0.00512

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

   and also multiplied by the shear_factor according to 15.7.1.4, with

   Shear_factor = 1.00

   lo/lou,min = lb/ld = 0.30

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

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

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

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

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

   y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.

   with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139

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

1 = Asl,ten/(b*d)*(fs1/fc) = 0.02701806

2 = Asl,com/(b*d)*(fs2/fc) = 0.04344945

v = Asl,mid/(b*d)*(fsv/fc) = 0.04697834

and confined core properties:

b = 890.00

d = 677.00

d' = 13.00

fcc (5A.2, TBDY) = 33.90003

cc (5A.5, TBDY) = 0.00227274

   c = confinement factor = 1.02727

1 = Asl,ten/(b*d)*(fs1/fc) = 0.03011747

2 = Asl,com/(b*d)*(fs2/fc) = 0.04843381

v = Asl,mid/(b*d)*(fsv/fc) = 0.05236752

Case/Assumption: Unconfinesd full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

su (4.9) = 0.15152684

Mu = MRc (4.14) = 6.7087E+008

u =   su (4.1) = 8.5351751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 9.2428803E-006
Mu = 9.4947E+008
----
with full section properties:
  b = 450.00
  d = 707.00
  d' = 43.00
  v = 0.00198039
    N = 20792.022
  fc = 33.00
   εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.0116768
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: εcu = 0.0116768
        ωwe ((5.4c), TBDY) = αse* ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.04178759
     where ωf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

       ωfx = 0.02973616
     Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
     αf = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
        bmax = 950.00
        hmax = 750.00
        From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00444444
           bw = 450.00
        effective stress from (A.35), ff,e = 773.4788

       ωfy = 0.02973616
     Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
     αf = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
        bmax = 950.00
        hmax = 750.00
        From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00444444
           bw = 450.00
        effective stress from (A.35), ff,e = 773.4788

       R = 40.00
       Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
       fu,f = 840.00
       Ef = 82000.00
        εu,f = 0.015
       αse ((5.4d), TBDY) = (αse1*Aext+αse2*Aint)/Asec = 0.53375773
          αse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
          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 = 464100.00 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 = 395025.00 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 = 173066.667 is the unconfined external core area which is equal to $\sum$bi2/6 as defined at (A.2).
        αse2 (>=αse1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
          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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00227274
c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.30
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esuv_nominal = 0.08,
   considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
   For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
   characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.09172662
   2 = Asl,com/(b*d)*(fs2/fc) = 0.05703813
   v = Asl,mid/(b*d)*(fsv/fc) = 0.0991765
and confined core properties:
  b = 390.00
  d = 677.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.90003
   cc (5A.5, TBDY) = 0.00227274
     c = confinement factor = 1.02727
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.11052844
   2 = Asl,com/(b*d)*(fs2/fc) = 0.06872961
   v = Asl,mid/(b*d)*(fsv/fc) = 0.11950537
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.21649239
Mu = MRc (4.14) = 9.4947E+008
  u =   su (4.1) = 9.2428803E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.4223E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.4223E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 1.4223E+006
  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 = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
   M/Vd = 2.00
     Mu = 1533.833
     Vu = 2.5087409E-020
   d = 0.8*h = 600.00
   Nu = 20792.022
   Ag = 337500.00
   From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 936062.473
   where:
  Vs,jacket = Vs,j1 + Vs,j2 = 837764.743
  Vs,j1 = 523602.964 is calculated for section web jacket, with:
    d = 600.00
    Av = 157079.633
    fy = 555.56

s = 100.00
    Vs,j1 is multiplied by   Col,j1 = 1.00
        s/d = 0.16666667
    Vs,j2 = 314161.779 is calculated for section flange jacket, with:
        d = 360.00
        Av = 157079.633
        fy = 555.56
        s = 100.00
    Vs,j2 is multiplied by   Col,j2 = 1.00
        s/d = 0.27777778
  Vs,core = Vs,c1 + Vs,c2 = 98297.73
    Vs,c1 = 98297.73 is calculated for section web core, with:
        d = 440.00
        Av = 100530.965
        fy = 555.56
        s = 250.00
    Vs,c1 is multiplied by   Col,c1 = 1.00
        s/d = 0.56818182
    Vs,c2 = 0.00 is calculated for section flange core, with:
        d = 200.00
        Av = 100530.965
        fy = 555.56
        s = 250.00
    Vs,c2 is multiplied by   Col,c2 = 0.00
        s/d = 1.25
  Vf ((11-3)-(11.4), ACI 440) = 463792.00
      f = 0.95, for fully-wrapped sections
    wf/sf = 1 (FRP strips adjacent to one another).
  In (11.3) sin + cos is replaced with (cot +cota)sina which is more a generalised expression,
  where   is the angle of the crack direction (see KANEPE).
  This later relation, considered as a function Vf(,), is implemented for every different fiber orientation ai,
  as well as for 2 crack directions, = 45° and = -45° to take into consideration the cyclic seismic loading.
  orientation 1:   1 = b1 + 90° = 90.00
  Vf = Min(|Vf(45, 1)|,|Vf(-45,a1)|), with:
  total thickness per orientation, tf1 = NL*t/NoDir = 1.00
  dfv = d (figure 11.2, ACI 440) = 707.00
  ffe ((11-5), ACI 440) = 328.00
      Ef = 82000.00
       fe = 0.004, from (11.6a), ACI 440
          with fu = 0.009
  From (11-11), ACI 440: Vs + Vf <= 1.0304E+006
      bw = 450.00

Calculation of Shear Strength at edge 2, Vr2 = 1.4223E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 1.4223E+006
  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 = 33.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
     Mu = 1533.833
     Vu = 2.5087409E-020
  d = 0.8*h = 600.00
  Nu = 20792.022
  Ag = 337500.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 936062.473
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 837764.743
   Vs,j1 = 523602.964 is calculated for section web jacket, with:
      d = 600.00
      Av = 157079.633

```
        fy = 555.56
        s = 100.00
      Vs,j1 is multiplied by  Col,j1 = 1.00
        s/d = 0.16666667
      Vs,j2 = 314161.779 is calculated for section flange jacket, with:
        d = 360.00
        Av = 157079.633
        fy = 555.56
        s = 100.00
      Vs,j2 is multiplied by  Col,j2 = 1.00
        s/d = 0.27777778
    Vs,core = Vs,c1 + Vs,c2 = 98297.73
      Vs,c1 = 98297.73 is calculated for section web core, with:
        d = 440.00
        Av = 100530.965
        fy = 555.56
        s = 250.00
      Vs,c1 is multiplied by  Col,c1 = 1.00
        s/d = 0.56818182
      Vs,c2 = 0.00 is calculated for section flange core, with:
        d = 200.00
        Av = 100530.965
        fy = 555.56
        s = 250.00
      Vs,c2 is multiplied by  Col,c2 = 0.00
        s/d = 1.25
    Vf ((11-3)-(11.4), ACI 440) = 463792.00
      f = 0.95, for fully-wrapped sections
    wf/sf = 1 (FRP strips adjacent to one another).
    In (11.3) sin  + cos  is replaced with (cot +cota)sina which is more a generalised expression,
    where   is the angle of the crack direction (see KANEPE).
    This later relation, considered as a function Vf( , ), is implemented for every different fiber orientation ai,
    as well as for 2 crack directions,  =45° and  =-45° to take into consideration the cyclic seismic loading.
    orientation 1:   1 = b1 + 90° = 90.00
    Vf = Min(|Vf(45,  1)|,|Vf(-45,a1)|), with:
    total thickness per orientation, tf1 = NL*t/NoDir = 1.00
    dfv = d (figure 11.2, ACI 440) = 707.00
    ffe ((11-5), ACI 440) = 328.00
       Ef = 82000.00
        fe = 0.004, from (11.6a), ACI 440
         with  fu = 0.009
    From (11-11), ACI 440: Vs + Vf <= 1.0304E+006
      bw = 450.00
---------------------------------------------------------------
---------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1
At local axis: 3


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


Start Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjtcs

Constant Properties
---------------------------------------------------------------
Knowledge Factor,   = 0.80
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
```

New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
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 = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
###
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.02727
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = 5.4210109E-020
EDGE -B-
Shear Force, Vb = -5.4210109E-020
BOTH EDGES
Axial Force, F = -20792.022
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1539.38
     -Compression: Asl,com = 1539.38
        -Middle: Asl,mid = 3612.832

Calculation of Shear Capacity ratio , Ve/Vr = 0.3589236
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 646212.952
with
Mpr1 = Max(Mu1+ , Mu1-) = 9.6932E+008
  Mu1+ = 9.6932E+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- = 9.6932E+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-) = 9.6932E+008

Mu2+ = 9.6932E+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- = 9.6932E+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 = 6.9132751E-006

Mu = 9.6932E+008

----

with full section properties:

b = 450.00

d = 907.00

d' = 43.00

ν = 0.0015437

N = 20792.022

fc = 33.00

εco (5A.5, TBDY) = 0.002

Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.0116768

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

From (5.4b), TBDY: εcu = 0.0116768

ωwe ((5.4c), TBDY) = αse*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.04178759

where ωf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.02973616

Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)

αf = 0.28545185

with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667

bmax = 950.00

hmax = 750.00

From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00444444

bw = 450.00

effective stress from (A.35), ff,e = 773.4788

ωfy = 0.02973616

Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)

αf = 0.28545185

with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667

bmax = 950.00

hmax = 750.00

From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00444444

bw = 450.00

effective stress from (A.35), ff,e = 773.4788

R = 40.00

Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00

fu,f = 840.00

Ef = 82000.00

εu,f = 0.015

αse ((5.4d), TBDY) = (αse1*Aext+αse2*Aint)/Asec = 0.53375773

αse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773

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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773

   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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363

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 = 2.48363

   psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593

      Lstir1 (Length of stirrups along Y) = 2160.00

      Astir1 (stirrups area) = 78.53982

   psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047

      Lstir2 (Length of stirrups along Y) = 1568.00

      Astir2 (stirrups area) = 50.26548

----

   psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078

   psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443

      Lstir1 (Length of stirrups along X) = 2560.00

      Astir1 (stirrups area) = 78.53982

   psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345

      Lstir2 (Length of stirrups along X) = 1968.00

      Astir2 (stirrups area) = 50.26548

      Asec = 562500.00

      s1 = 100.00

      s2 = 250.00

   fywe1 = 694.45

   fywe2 = 694.45

   fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00227274

      c = confinement factor = 1.02727

 y1 = 0.00140044

 sh1 = 0.0044814

ft1 = 466.8167

fy1 = 389.0139

 su1 = 0.00512

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

   and also multiplied by the shear_factor according to 15.7.1.4, with

   Shear_factor = 1.00

   lo/lou,min = lb/ld = 0.30

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

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

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

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

    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.

    with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139

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

 y2 = 0.00140044

 sh2 = 0.0044814

ft2 = 466.8167

fy2 = 389.0139

 su2 = 0.00512

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

   and also multiplied by the shear_factor according to 15.7.1.4, with

   Shear_factor = 1.00

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

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
 y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
 with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
 with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
 suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
 y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
 with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
 with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04446081
2 = Asl,com/(b*d)*(fs2/fc) = 0.04446081
v = Asl,mid/(b*d)*(fsv/fc) = 0.1043468
and confined core properties:
b = 390.00
d = 877.00
d' = 13.00
fcc (5A.2, TBDY) = 33.90003
cc (5A.5, TBDY) = 0.00227274
c = confinement factor = 1.02727
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05305581
2 = Asl,com/(b*d)*(fs2/fc) = 0.05305581
v = Asl,mid/(b*d)*(fsv/fc) = 0.12451875
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.18345742
Mu = MRc (4.14) = 9.6932E+008
u = su (4.1) = 6.9132751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
u = 6.9132751E-006
Mu = 9.6932E+008
----
with full section properties:
b = 450.00
d = 907.00
d' = 43.00
v = 0.0015437
N = 20792.022

fc = 33.00
  co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768
   The Shear_factor is considered equal to 1 (pure moment strength)
   From (5.4b), TBDY: cu = 0.0116768
    we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.04178759
   where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
   ----
    fx = 0.02973616
   Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
   af = 0.28545185
   with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
    bmax = 950.00
    hmax = 750.00
    From EC8 A4.4.3(6), pf = 2tf/bw = 0.00444444
     bw = 450.00
    effective stress from (A.35), ff,e = 773.4788
   ----
    fy = 0.02973616
   Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
   af = 0.28545185
   with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
    bmax = 950.00
    hmax = 750.00
    From EC8 A4.4.3(6), pf = 2tf/bw = 0.00444444
     bw = 450.00
    effective stress from (A.35), ff,e = 773.4788

    R = 40.00
    Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
    fu,f = 840.00
    Ef = 82000.00
    u,f = 0.015
    ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
     ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
     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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
     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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
  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 = 2.48363
    psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
     Lstir1 (Length of stirrups along Y) = 2160.00
     Astir1 (stirrups area) = 78.53982
    psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047

```
            Lstir2 (Length of stirrups along Y) = 1568.00
            Astir2 (stirrups area) = 50.26548
     -----------------------------------------------------------------
       psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
       psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
            Lstir1 (Length of stirrups along X) = 2560.00
            Astir1 (stirrups area) = 78.53982
       psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
            Lstir2 (Length of stirrups along X) = 1968.00
            Astir2 (stirrups area) = 50.26548
     -----------------------------------------------------------------
            Asec = 562500.00
            s1 = 100.00
            s2 = 250.00
         fywe1 = 694.45
         fywe2 = 694.45
         fce  = 33.00
     From ((5.A5), TBDY), TBDY:  cc = 0.00227274
          c = confinement factor = 1.02727
   y1 = 0.00140044
   sh1 = 0.0044814
  ft1 = 466.8167
  fy1 = 389.0139
   su1 = 0.00512
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/ld = 0.30
      su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esu1_nominal = 0.08,
     For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
     characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
       with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
       with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
   y2 = 0.00140044
   sh2 = 0.0044814
  ft2 = 466.8167
  fy2 = 389.0139
   su2 = 0.00512
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/lb,min = 0.30
      su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esu2_nominal = 0.08,
     For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
     characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
       with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
       with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
   yv = 0.00140044
   shv = 0.0044814
  ftv = 466.8167
  fyv = 389.0139
   suv = 0.00512
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/ld = 0.30
      suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esuv_nominal = 0.08,
     considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
     For calculation of esuv_nominal and  yv, shv,ftv,fyv, it is considered
     characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
       with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
```

with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.04446081
    2 = Asl,com/(b*d)*(fs2/fc) = 0.04446081
    v = Asl,mid/(b*d)*(fsv/fc) = 0.1043468
and confined core properties:
  b = 390.00
  d = 877.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.90003
   cc (5A.5, TBDY) = 0.00227274
     c = confinement factor = 1.02727
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.05305581
    2 = Asl,com/(b*d)*(fs2/fc) = 0.05305581
    v = Asl,mid/(b*d)*(fsv/fc) = 0.12451875
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.18345742
Mu = MRc (4.14) = 9.6932E+008
  u =   su (4.1) = 6.9132751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 6.9132751E-006
Mu = 9.6932E+008
----
with full section properties:
  b = 450.00
  d = 907.00
  d' = 43.00
  v = 0.0015437
   N = 20792.022
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.0116768
     we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.04178759
    where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----
     fx = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
     bmax = 950.00
     hmax = 750.00
     From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
      bw = 450.00
     effective stress from (A.35), ff,e = 773.4788
    ----
     fy = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
     bmax = 950.00

hmax = 750.00
From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
   bw = 450.00
effective stress from (A.35), ff,e = 773.4788

R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
fu,f = 840.00
Ef = 82000.00
 u,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
   ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
   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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
   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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
   Lstir1 (Length of stirrups along Y) = 2160.00
   Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
   Lstir2 (Length of stirrups along Y) = 1568.00
   Astir2 (stirrups area) = 50.26548
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
   Lstir1 (Length of stirrups along X) = 2560.00
   Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
   Lstir2 (Length of stirrups along X) = 1968.00
   Astir2 (stirrups area) = 50.26548

   Asec = 562500.00
   s1 = 100.00
   s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00227274
   c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139

su1 = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
  su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esu1_nominal = 0.08,
  For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
  characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
  with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
  with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/lb,min = 0.30
  su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esu2_nominal = 0.08,
  For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
  characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
  with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
  with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
  suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esuv_nominal = 0.08,
  considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
  For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
  characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
  with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04446081
2 = Asl,com/(b*d)*(fs2/fc) = 0.04446081
v = Asl,mid/(b*d)*(fsv/fc) = 0.1043468
and confined core properties:
b = 390.00
d = 877.00
d' = 13.00
fcc (5A.2, TBDY) = 33.90003
cc (5A.5, TBDY) = 0.00227274
c = confinement factor = 1.02727
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05305581
2 = Asl,com/(b*d)*(fs2/fc) = 0.05305581
v = Asl,mid/(b*d)*(fsv/fc) = 0.12451875
Case/Assumption: Unconfinesd full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.18345742
Mu = MRc (4.14) = 9.6932E+008
u = su (4.1) = 6.9132751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
 φu = 6.9132751E-006
Mu = 9.6932E+008
----
with full section properties:
 b = 450.00
 d = 907.00
 d' = 43.00
 ν = 0.0015437
   N = 20792.022
 fc = 33.00
  εco (5A.5, TBDY) = 0.002
 Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.0116768
   The Shear_factor is considered equal to 1 (pure moment strength)
   From (5.4b), TBDY: εcu = 0.0116768
     we ((5.4c), TBDY) = αse* ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.04178759
   where ωf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

    ωfx = 0.02973616
   Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
   αf = 0.28545185
   with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
     bmax = 950.00
     hmax = 750.00
     From EC8 A4.4.3(6), ρf = 2tf/bw = 0.00444444
       bw = 450.00
     effective stress from (A.35), ff,e = 773.4788

    ωfy = 0.02973616
   Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
   αf = 0.28545185
   with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
     bmax = 950.00
     hmax = 750.00
     From EC8 A4.4.3(6), ρf = 2tf/bw = 0.00444444
       bw = 450.00
     effective stress from (A.35), ff,e = 773.4788

    R = 40.00
    Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
    fu,f = 840.00
    Ef = 82000.00
     εu,f = 0.015
    αse ((5.4d), TBDY) = (αse1*Aext+αse2*Aint)/Asec = 0.53375773
      αse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
      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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
    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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
    psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
      Lstir1 (Length of stirrups along Y) = 2160.00
      Astir1 (stirrups area) = 78.53982
    psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
      Lstir2 (Length of stirrups along Y) = 1568.00
      Astir2 (stirrups area) = 50.26548
    ----
    psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
    psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
      Lstir1 (Length of stirrups along X) = 2560.00
      Astir1 (stirrups area) = 78.53982
    psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
      Lstir2 (Length of stirrups along X) = 1968.00
      Astir2 (stirrups area) = 50.26548

    Asec = 562500.00
     s1 = 100.00
     s2 = 250.00
    fywe1 = 694.45
    fywe2 = 694.45
    fce = 33.00
  From ((5.A5), TBDY), TBDY: cc = 0.00227274
    c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
  su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esu1_nominal = 0.08,
  For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
  characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
  with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
  with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/lb,min = 0.30
  su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
 y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
  with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
  with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
 yv = 0.00140044
 shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
 suv = 0.00512
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 lo/lou,min = lb/ld = 0.30
  suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
 From table 5A.1, TBDY: esuv_nominal = 0.08,
 considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
 For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
 characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
  with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.04446081
 2 = Asl,com/(b*d)*(fs2/fc) = 0.04446081
 v = Asl,mid/(b*d)*(fsv/fc) = 0.1043468
and confined core properties:
 b = 390.00
 d = 877.00
 d' = 13.00
 fcc (5A.2, TBDY) = 33.90003
  cc (5A.5, TBDY) = 0.00227274
   c = confinement factor = 1.02727
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.05305581
  2 = Asl,com/(b*d)*(fs2/fc) = 0.05305581
  v = Asl,mid/(b*d)*(fsv/fc) = 0.12451875
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.18345742
Mu = MRc (4.14) = 9.6932E+008
 u =   su (4.1) = 6.9132751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.8004E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.8004E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 1.8004E+006
 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 = 33.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
 M/Vd = 2.00
  Mu = 1.22911

```
     Vu = 5.4210109E-020
  d = 0.8*h = 760.00
  Nu = 20792.022
  Ag = 427500.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 1.1114E+006
  where:
 Vs,jacket = Vs,j1 + Vs,j2 = 977392.20
  Vs,j1 = 314161.779 is calculated for section web jacket, with:
    d = 360.00
    Av = 157079.633
    fy = 555.56
    s = 100.00
  Vs,j1 is multiplied by   Col,j1 = 1.00
    s/d = 0.27777778
  Vs,j2 = 663230.422 is calculated for section flange jacket, with:
    d = 760.00
    Av = 157079.633
    fy = 555.56
    s = 100.00
  Vs,j2 is multiplied by   Col,j2 = 1.00
    s/d = 0.13157895
 Vs,core = Vs,c1 + Vs,c2 = 134042.359
  Vs,c1 = 0.00 is calculated for section web core, with:
    d = 200.00
    Av = 100530.965
    fy = 555.56
    s = 250.00
  Vs,c1 is multiplied by   Col,c1 = 0.00
    s/d = 1.25
  Vs,c2 = 134042.359 is calculated for section flange core, with:
    d = 600.00
    Av = 100530.965
    fy = 555.56
    s = 250.00
  Vs,c2 is multiplied by   Col,c2 = 1.00
    s/d = 0.41666667
  Vf ((11-3)-(11.4), ACI 440) = 594992.00
    f = 0.95, for fully-wrapped sections
  wf/sf = 1 (FRP strips adjacent to one another).
  In (11.3) sin  + cos  is replaced with (cot +cota)sina which is more a generalised expression,
  where   is the angle of the crack direction (see KANEPE).
  This later relation, considered as a function Vf( , ), is implemented for every different fiber orientation ai,
  as well as for 2 crack directions,  = 45° and  = -45° to take into consideration the cyclic seismic loading.
  orientation 1:   1 = b1 +  90° = 90.00
  Vf = Min(|Vf(45,  1)|,|Vf(-45,a1)|), with:
  total thickness per orientation, tf1 = NL*t/NoDir = 1.00
  dfv = d (figure 11.2, ACI 440) = 907.00
  ffe ((11-5), ACI 440) = 328.00
    Ef = 82000.00
     fe = 0.004, from (11.6a), ACI 440
       with  fu = 0.009
  From (11-11), ACI 440: Vs + Vf <= 1.3051E+006
    bw = 450.00
-----------------------------------------------------------
------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 1.8004E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 1.8004E+006
  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 = 33.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
```

Mu = 1.22911
Vu = 5.4210109E-020
d = 0.8*h = 760.00
Nu = 20792.022
Ag = 427500.00
From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 1.1114E+006
where:
Vs,jacket = Vs,j1 + Vs,j2 = 977392.20
Vs,j1 = 314161.779 is calculated for section web jacket, with:
    d = 360.00
    Av = 157079.633
    fy = 555.56
    s = 100.00
Vs,j1 is multiplied by   Col,j1 = 1.00
    s/d = 0.27777778
Vs,j2 = 663230.422 is calculated for section flange jacket, with:
    d = 760.00
    Av = 157079.633
    fy = 555.56
    s = 100.00
Vs,j2 is multiplied by   Col,j2 = 1.00
    s/d = 0.13157895
Vs,core = Vs,c1 + Vs,c2 = 134042.359
Vs,c1 = 0.00 is calculated for section web core, with:
    d = 200.00
    Av = 100530.965
    fy = 555.56
    s = 250.00
Vs,c1 is multiplied by   Col,c1 = 0.00
    s/d = 1.25
Vs,c2 = 134042.359 is calculated for section flange core, with:
    d = 600.00
    Av = 100530.965
    fy = 555.56
    s = 250.00
Vs,c2 is multiplied by   Col,c2 = 1.00
    s/d = 0.41666667
Vf ((11-3)-(11.4), ACI 440) = 594992.00
    f = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sin + cos is replaced with (cot +cota)sina which is more a generalised expression,
where   is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(,), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, = 45° and = -45° to take into consideration the cyclic seismic loading.
orientation 1:   1 = b1 + 90° = 90.00
Vf = Min(|Vf(45, 1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.00
dfv = d (figure 11.2, ACI 440) = 907.00
ffe ((11-5), ACI 440) = 328.00
    Ef = 82000.00
     fe = 0.004, from (11.6a), ACI 440
       with fu = 0.009
From (11-11), ACI 440: Vs + Vf < = 1.3051E+006
    bw = 450.00

End Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column JTC1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rcjtcs

Constant Properties

Knowledge Factor,   = 0.80
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 Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lb/ld = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

Stepwise Properties

Bending Moment, M = -131936.98
Shear Force, V2 = -5103.636
Shear Force, V3 = 67.97343
Axial Force, F = -21366.38
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1539.38
     -Compression: Asl,com = 2475.575
         -Middle: Asl,mid = 2676.637
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,jacket = 1231.504
     -Compression: Asl,com,jacket = 1859.823
         -Middle: Asl,mid,jacket = 2060.885
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,core = 307.8761
     -Compression: Asl,com,core = 615.7522
         -Middle: Asl,mid,core = 615.7522
Mean Diameter of Tension Reinforcement, DbL = 16.57143

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.00172926
θu = θy + θp = 0.00172926

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00172926 ((4.29),Biskinis Phd))
  My = 4.9044E+008
  Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1941.008
  From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.8350E+014
      factor = 0.30
        Ag = 562500.00
        Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
        N = 21366.38
      Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 6.1166E+014

Calculation of Yielding Moment My

Calculation of φy and My according to Annex 7 -

Assuming neutral axis within flange (ξy < t/d, compression zone rectangular) with:
flange width, b = 950.00
web width, bw = 450.00
flange thickness, t = 450.00

  φy = Min(φy_ten, φy_com)
  φy_ten = 2.7529339E-006
  with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 311.2112
      d = 707.00
       ξy = 0.20051568
      A = 0.01006514
      B = 0.0047321
       with pt = 0.00229194
          pc = 0.00368581
          pv = 0.00398517
          N = 21366.38
          b = 950.00
          " = 0.06082037
  φy_comp = 1.5813624E-005
  with fc* (12.3, (ACI 440)) = 33.31981
      fc = 33.00
      fl = 0.5419822
      b = bmax = 950.00
      h = hmax = 750.00
      Ag = 0.5625
          g = pt + pc + pv = 0.00996292
          rc = 40.00
          Ae/Ac = 0.30198841
          Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
      effective strain from (12.5) and (12.12), efe = 0.004
       fu = 0.009
      Ef = 82000.00
      Ec = 26999.444
       ξy = 0.19868694
      A = 0.00989131
      B = 0.00462988
       with Es = 200000.00
CONFIRMATION: ξy = 0.19954485 < t/d

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

 - Calculation of p -

From table 10-8: p = 0.00
with:
 - Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
   shear control ratio VyE/VCol0E = 0.44505685
   d = d_external = 707.00
   s = s_external = 0.00
 - t = s1 + s2 + 2*tf/bw*(ffe/fs) = 0.00620038
   jacket: s1 = Av1*Lstir1/(s1*Ag) = 0.00301593
        Av1 = 78.53982, is the area of every stirrup parallel to loading (shear) direction
        Lstir1 = 2160.00, is the total Length of all stirrups parallel to loading (shear) direction
        s1 = 100.00
   core: s2 = Av2*Lstir2/(s2*Ag) = 0.00056047
        Av2 = 50.26548, is the area of every stirrup parallel to loading (shear) direction
        Lstir2 = 1568.00, 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 = 21366.38
     Ag = 562500.00
     f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 33.00
     fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein =
555.56
     fytE = (fy_ext_Trans_Reinf* s1+fy_int_Trans_Reinf* s2)/(s1+ s2) = 555.56
pl = Area_Tot_Long_Rein/(b*d) = 0.00996292
   b = 950.00
   d = 707.00
    f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column JTC1 of floor 1
At local axis: 2
Integration Section: (a)

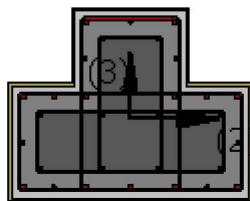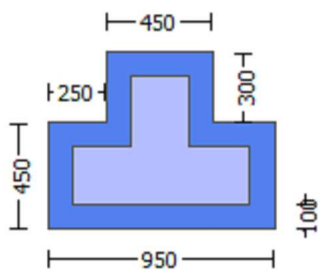
Calculation No. 3

column C1, Floor 1

Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (3)

Start Of Calculation of Shear Capacity for element: column JTC1 of floor 1
At local axis: 3
Integration Section: (a)
Section Type: rcjtcs

Constant Properties

Knowledge Factor, = 0.80
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 Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
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 = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
##
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min =lb/ld = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00

Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -131936.98
Shear Force, Va = 67.97343
EDGE -B-
Bending Moment, Mb = -71373.128
Shear Force, Vb = -67.97343
BOTH EDGES
Axial Force, F = -21366.38
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1539.38
     -Compression: Asl,com = 2475.575
          -Middle: Asl,mid = 2676.637
Mean Diameter of Tension Reinforcement, DbL,ten = 16.57143

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 1.1081E+006
Vn ((10.3), ASCE 41-17) = knl*VColO = 1.1081E+006
  VCol = 1.1081E+006
  knl = 1.00
     displacement_ductility_demand = 0.00425521

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 = 3.23501
     Mu = 131936.98
     Vu = 67.97343
   d = 0.8*h = 600.00
   Nu = 21366.38
   Ag = 337500.00
   From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 842449.486
   where:
  Vs,jacket = Vs,j1 + Vs,j2 = 753982.237
   Vs,j1 = 471238.898 is calculated for section web jacket, with:
     d = 600.00
     Av = 157079.633
     fy = 500.00
     s = 100.00
   Vs,j1 is multiplied by Col,j1 = 1.00
     s/d = 0.16666667
   Vs,j2 = 282743.339 is calculated for section flange jacket, with:
     d = 360.00
     Av = 157079.633
     fy = 500.00
     s = 100.00
   Vs,j2 is multiplied by Col,j2 = 1.00
     s/d = 0.27777778
  Vs,core = Vs,c1 + Vs,c2 = 88467.249
   Vs,c1 = 88467.249 is calculated for section web core, with:
     d = 440.00

Av = 100530.965
      fy = 500.00
      s = 250.00
    Vs,c1 is multiplied by   Col,c1 = 1.00
      s/d = 0.56818182
    Vs,c2 = 0.00 is calculated for section flange core, with:
      d = 200.00
      Av = 100530.965
      fy = 500.00
      s = 250.00
    Vs,c2 is multiplied by   Col,c2 = 0.00
      s/d = 1.25
    Vf ((11-3)-(11.4), ACI 440) = 463792.00
      f = 0.95, for fully-wrapped sections
    wf/sf = 1 (FRP strips adjacent to one another).
   In (11.3) sin + cos is replaced with (cot +cota)sina which is more a generalised expression,
   where   is the angle of the crack direction (see KANEPE).
   This later relation, considered as a function Vf(,), is implemented for every different fiber orientation ai,
   as well as for 2 crack directions, =45° and =-45° to take into consideration the cyclic seismic loading.
   orientation 1:   1 = b1 + 90° = 90.00
   Vf = Min(|Vf(45, 1)|,|Vf(-45,a1)|), with:
   total thickness per orientation, tf1 = NL*t/NoDir = 1.00
   dfv = d (figure 11.2, ACI 440) = 707.00
   ffe ((11-5), ACI 440) = 328.00
      Ef = 82000.00
       fe = 0.004, from (11.6a), ACI 440
         with fu = 0.009
    From (11-11), ACI 440: Vs + Vf <= 896810.169
      bw = 450.00

----
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   = 7.3583453E-006
 y = (My*Ls/3)/EIeff = 0.00172926 ((4.29),Biskinis Phd))
  My = 4.9044E+008
  Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1941.008
  From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.8350E+014
     factor = 0.30
        Ag = 562500.00
        Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
        N = 21366.38
     Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 6.1166E+014

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 = 950.00
web width, bw = 450.00
flange thickness, t = 450.00
----
  y = Min(y_ten, y_com)
  y_ten = 2.7529339E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 311.2112
     d = 707.00
      y = 0.20051568
     A = 0.01006514
     B = 0.0047321
      with pt = 0.00229194

```
        pc = 0.00368581
        pv = 0.00398517
        N = 21366.38
        b = 950.00
         " = 0.06082037
  y_comp = 1.5813624E-005
 with fc* (12.3, (ACI 440)) = 33.31981
     fc = 33.00
     fl = 0.5419822
     b = bmax = 950.00
     h = hmax = 750.00
     Ag = 0.5625
        g = pt + pc + pv = 0.00996292
      rc = 40.00
      Ae/Ac = 0.30198841
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
    effective strain from (12.5) and (12.12), efe = 0.004
     fu = 0.009
    Ef = 82000.00
   Ec = 26999.444
    y = 0.19868694
   A = 0.00989131
   B = 0.00462988
    with Es = 200000.00
CONFIRMATION:  y = 0.19954485 < t/d
------------------------------------------------------------
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
------------------------------------------------------------
End Of Calculation of Shear Capacity for element: column JTC1 of floor 1
At local axis: 3
Integration Section: (a)


------------------------------------------------------------
```
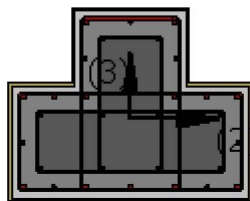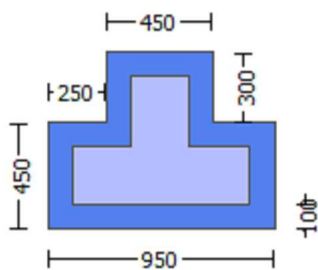
Calculation No. 4

column C1, Floor 1

Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (u)

Edge: Start

Local Axis: (3)

Start Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcjtcs

Constant Properties

Knowledge Factor,   = 0.80
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
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 = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
###
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.02727
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°

Number of layers, NL = 1
Radius of rounding corners, R = 40.00

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = -2.5087409E-020
EDGE -B-
Shear Force, Vb = 2.5087409E-020
BOTH EDGES
Axial Force, F = -20792.022
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
   -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 1539.38
    -Compression: Asl,com = 2475.575
      -Middle: Asl,mid = 2676.637

Calculation of Shear Capacity ratio , Ve/Vr = 0.44505685
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 632982.444
with
Mpr1 = Max(Mu1+ , Mu1-) = 9.4947E+008
   Mu1+ = 6.7087E+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- = 9.4947E+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-) = 9.4947E+008
   Mu2+ = 6.7087E+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- = 9.4947E+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 = 8.5351751E-006
Mu = 6.7087E+008
----
with full section properties:
  b = 950.00
  d = 707.00
  d' = 43.00
  v = 0.00093808
     N = 20792.022
  fc = 33.00
   εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.0116768
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: εcu = 0.0116768
       ωwe ((5.4c), TBDY) = αse* $\rho sh,min$*fywe/fce+Min(ωfx, ωfy) = 0.04178759
     where ωf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

       ωfx = 0.02973616
     Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
     αf = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
       bmax = 950.00

hmax = 750.00
From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
   bw = 450.00
effective stress from (A.35), ff,e = 773.4788

----

fy = 0.02973616
Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
af = 0.28545185
with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
  bmax = 950.00
  hmax = 750.00
  From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
    bw = 450.00
  effective stress from (A.35), ff,e = 773.4788

R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
fu,f = 840.00
Ef = 82000.00
 u,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
  ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
  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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
  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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
  Lstir1 (Length of stirrups along Y) = 2160.00
  Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
  Lstir2 (Length of stirrups along Y) = 1568.00
  Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
  Lstir1 (Length of stirrups along X) = 2560.00
  Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
  Lstir2 (Length of stirrups along X) = 1968.00
  Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00

```
        s2 = 250.00
      fywe1 = 694.45
      fywe2 = 694.45
       fce  = 33.00
   From ((5.A5), TBDY), TBDY:  cc = 0.00227274
       c = confinement factor = 1.02727
  y1 = 0.00140044
 sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
 su1 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.30
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esu1_nominal = 0.08,
   For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
   characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.00140044
 sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
 su2 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/lb,min = 0.30
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esu2_nominal = 0.08,
   For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
   characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00140044
 shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
 suv = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.30
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esuv_nominal = 0.08,
   considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
   For calculation of esuv_nominal and  yv, shv,ftv,fyv, it is considered
   characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.02701806
   2 = Asl,com/(b*d)*(fs2/fc) = 0.04344945
   v = Asl,mid/(b*d)*(fsv/fc) = 0.04697834
and confined core properties:
  b = 890.00
  d = 677.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.90003
   cc (5A.5, TBDY) = 0.00227274
      c = confinement factor = 1.02727
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.03011747
    2 = Asl,com/(b*d)*(fs2/fc) = 0.04843381
```

v = Asl,mid/(b*d)*(fsv/fc) = 0.05236752
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.15152684
Mu = MRc (4.14) = 6.7087E+008
 u =   su (4.1) = 8.5351751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 9.2428803E-006
Mu = 9.4947E+008
----
with full section properties:
  b = 450.00
  d = 707.00
  d' = 43.00
  v = 0.00198039
    N = 20792.022
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.0116768
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx,   fy) = 0.04178759
    where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----
      fx = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788
    ----
      fy = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788

      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
      fu,f = 840.00
      Ef = 82000.00
       u,f = 0.015
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
        ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
        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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
    psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
        Lstir1 (Length of stirrups along Y) = 2160.00
        Astir1 (stirrups area) = 78.53982
    psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
        Lstir2 (Length of stirrups along Y) = 1568.00
        Astir2 (stirrups area) = 50.26548
    ----
    psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
    psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
        Lstir1 (Length of stirrups along X) = 2560.00
        Astir1 (stirrups area) = 78.53982
    psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
        Lstir2 (Length of stirrups along X) = 1968.00
        Astir2 (stirrups area) = 50.26548

    Asec = 562500.00
    s1 = 100.00
    s2 = 250.00
  fywe1 = 694.45
  fywe2 = 694.45
  fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00227274
    c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
  su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
  with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
  with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044

sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/lb,min = 0.30
   su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esu2_nominal = 0.08,
  For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
  characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
   y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
 yv = 0.00140044
 shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
 suv = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
   suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esuv_nominal = 0.08,
  considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
  For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
  characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
   y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.09172662
  2 = Asl,com/(b*d)*(fs2/fc) = 0.05703813
  v = Asl,mid/(b*d)*(fsv/fc) = 0.0991765
and confined core properties:
 b = 390.00
 d = 677.00
 d' = 13.00
 fcc (5A.2, TBDY) = 33.90003
  cc (5A.5, TBDY) = 0.00227274
    c = confinement factor = 1.02727
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.11052844
  2 = Asl,com/(b*d)*(fs2/fc) = 0.06872961
  v = Asl,mid/(b*d)*(fsv/fc) = 0.11950537
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.21649239
Mu = MRc (4.14) = 9.4947E+008
 u =   su (4.1) = 9.2428803E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
 u = 8.5351751E-006

Mu = 6.7087E+008

----

with full section properties:
  b = 950.00
  d = 707.00
  d' = 43.00
  v = 0.00093808
    N = 20792.022
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: cu = 0.0116768
        we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.04178759
     where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
     ----
        fx = 0.02973616
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
        bmax = 950.00
        hmax = 750.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
           bw = 450.00
        effective stress from (A.35), ff,e = 773.4788
     ----
        fy = 0.02973616
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
        bmax = 950.00
        hmax = 750.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
           bw = 450.00
        effective stress from (A.35), ff,e = 773.4788

        R = 40.00
        Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
        fu,f = 840.00
        Ef = 82000.00
         u,f = 0.015
        ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
           ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
           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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
           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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363

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 = 2.48363
    psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
        Lstir1 (Length of stirrups along Y) = 2160.00
        Astir1 (stirrups area) = 78.53982
    psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
        Lstir2 (Length of stirrups along Y) = 1568.00
        Astir2 (stirrups area) = 50.26548

----
    psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
    psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
        Lstir1 (Length of stirrups along X) = 2560.00
        Astir1 (stirrups area) = 78.53982
    psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
        Lstir2 (Length of stirrups along X) = 1968.00
        Astir2 (stirrups area) = 50.26548

    Asec = 562500.00
    s1 = 100.00
    s2 = 250.00
    fywe1 = 694.45
    fywe2 = 694.45
    fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00227274
    c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.30
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00

lo/lou,min = lb/ld = 0.30
   suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esuv_nominal = 0.08,
  considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
  For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
  characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
   y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
   with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
   with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.02701806
  2 = Asl,com/(b*d)*(fs2/fc) = 0.04344945
  v = Asl,mid/(b*d)*(fsv/fc) = 0.04697834
and confined core properties:
  b = 890.00
  d = 677.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.90003
   cc (5A.5, TBDY) = 0.00227274
     c = confinement factor = 1.02727
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.03011747
   2 = Asl,com/(b*d)*(fs2/fc) = 0.04843381
   v = Asl,mid/(b*d)*(fsv/fc) = 0.05236752
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.15152684
Mu = MRc (4.14) = 6.7087E+008
  u = su (4.1) = 8.5351751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
  u = 9.2428803E-006
Mu = 9.4947E+008
----
with full section properties:
  b = 450.00
  d = 707.00
  d' = 43.00
  v = 0.00198039
    N = 20792.022
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.0116768
     we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx,   fy) = 0.04178759
    where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----
     fx = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+ (hmax-2R)^2)/3 = 160566.667
     bmax = 950.00
     hmax = 750.00
     From EC8 A 4.4.3(6), pf = 2tf/bw = 0.00444444

bw = 450.00
effective stress from (A.35), ff,e = 773.4788
----
fy = 0.02973616
Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
af = 0.28545185
with Unconfined area = ((bmax-2R)^2+ (hmax-2R)^2)/3 = 160566.667
bmax = 950.00
hmax = 750.00
From EC8 A 4.4.3(6), pf = 2tf/bw = 0.00444444
bw = 450.00
effective stress from (A.35), ff,e = 773.4788

R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
fu,f = 840.00
Ef = 82000.00
u,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ ase2*Aint)/Asec = 0.53375773
ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45

fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00227274
c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and   y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and   y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and   yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09172662
2 = Asl,com/(b*d)*(fs2/fc) = 0.05703813
v = Asl,mid/(b*d)*(fsv/fc) = 0.0991765
and confined core properties:
b = 390.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 33.90003
cc (5A.5, TBDY) = 0.00227274
c = confinement factor = 1.02727
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11052844
2 = Asl,com/(b*d)*(fs2/fc) = 0.06872961
v = Asl,mid/(b*d)*(fsv/fc) = 0.11950537
Case/Assumption: Unconfinesd full section - Steel rupture

' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.21649239
Mu = MRc (4.14) = 9.4947E+008
  u =   su (4.1) = 9.2428803E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.4223E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.4223E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
   VCol0 = 1.4223E+006
   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 = 33.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
     Mu = 1533.833
     Vu = 2.5087409E-020
  d = 0.8*h = 600.00
  Nu = 20792.022
  Ag = 337500.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 936062.473
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 837764.743
  Vs,j1 = 523602.964 is calculated for section web jacket, with:
     d = 600.00
     Av = 157079.633
     fy = 555.56
     s = 100.00
  Vs,j1 is multiplied by Col,j1 = 1.00
     s/d = 0.16666667
  Vs,j2 = 314161.779 is calculated for section flange jacket, with:
     d = 360.00
     Av = 157079.633
     fy = 555.56
     s = 100.00
  Vs,j2 is multiplied by Col,j2 = 1.00
     s/d = 0.27777778
  Vs,core = Vs,c1 + Vs,c2 = 98297.73
  Vs,c1 = 98297.73 is calculated for section web core, with:
     d = 440.00
     Av = 100530.965
     fy = 555.56
     s = 250.00
  Vs,c1 is multiplied by Col,c1 = 1.00
     s/d = 0.56818182
  Vs,c2 = 0.00 is calculated for section flange core, with:
     d = 200.00
     Av = 100530.965
     fy = 555.56
     s = 250.00
  Vs,c2 is multiplied by Col,c2 = 0.00
     s/d = 1.25

Vf ((11-3)-(11.4), ACI 440) = 463792.00
  φf = 0.95, for fully-wrapped sections
 wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinβ + cosβ is replaced with (cotθ+cotα)sinα which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45, α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.00
dfv = d (figure 11.2, ACI 440) = 707.00
ffe ((11-5), ACI 440) = 328.00
  Ef = 82000.00
   εfe = 0.004, from (11.6a), ACI 440
     with εfu = 0.009
 From (11-11), ACI 440: Vs + Vf <= 1.0304E+006
   bw = 450.00

Calculation of Shear Strength at edge 2, Vr2 = 1.4223E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 1.4223E+006
  knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ φf*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 = 33.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
    Mu = 1533.833
    Vu = 2.5087409E-020
  d = 0.8*h = 600.00
  Nu = 20792.022
  Ag = 337500.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 936062.473
  where:
 Vs,jacket = Vs,j1 + Vs,j2 = 837764.743
 Vs,j1 = 523602.964 is calculated for section web jacket, with:
   d = 600.00
   Av = 157079.633
   fy = 555.56
   s = 100.00
 Vs,j1 is multiplied by αCol,j1 = 1.00
   s/d = 0.16666667
 Vs,j2 = 314161.779 is calculated for section flange jacket, with:
   d = 360.00
   Av = 157079.633
   fy = 555.56
   s = 100.00
 Vs,j2 is multiplied by αCol,j2 = 1.00
   s/d = 0.27777778
 Vs,core = Vs,c1 + Vs,c2 = 98297.73
 Vs,c1 = 98297.73 is calculated for section web core, with:
   d = 440.00
   Av = 100530.965
   fy = 555.56
   s = 250.00
 Vs,c1 is multiplied by αCol,c1 = 1.00
   s/d = 0.56818182
 Vs,c2 = 0.00 is calculated for section flange core, with:
   d = 200.00
   Av = 100530.965
   fy = 555.56
   s = 250.00
 Vs,c2 is multiplied by αCol,c2 = 0.00

s/d = 1.25
   Vf ((11-3)-(11.4), ACI 440) = 463792.00
      f = 0.95, for fully-wrapped sections
   wf/sf = 1 (FRP strips adjacent to one another).
   In (11.3) sin + cos is replaced with (cot +cota)sina which is more a generalised expression,
   where   is the angle of the crack direction (see KANEPE).
   This later relation, considered as a function Vf(,), is implemented for every different fiber orientation ai,
   as well as for 2 crack directions, = 45° and = -45° to take into consideration the cyclic seismic loading.
   orientation 1:   1 = b1 + 90° = 90.00
   Vf = Min(|Vf(45, 1)|,|Vf(-45,a1)|), with:
   total thickness per orientation, tf1 = NL*t/NoDir = 1.00
   dfv = d (figure 11.2, ACI 440) = 707.00
   ffe ((11-5), ACI 440) = 328.00
      Ef = 82000.00
       fe = 0.004, from (11.6a), ACI 440
         with fu = 0.009
    From (11-11), ACI 440: Vs + Vf < = 1.0304E+006
      bw = 450.00

End Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjtcs

Constant Properties

Knowledge Factor,   = 0.80
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
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 = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
###
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.02727
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = 5.4210109E-020
EDGE -B-
Shear Force, Vb = -5.4210109E-020
BOTH EDGES
Axial Force, F = -20792.022
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
   -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 1539.38
    -Compression: Asl,com = 1539.38
       -Middle: Asl,mid = 3612.832

Calculation of Shear Capacity ratio , Ve/Vr = 0.3589236
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 646212.952
with
Mpr1 = Max(Mu1+ , Mu1-) = 9.6932E+008
   Mu1+ = 9.6932E+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- = 9.6932E+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-) = 9.6932E+008
   Mu2+ = 9.6932E+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- = 9.6932E+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 = 6.9132751E-006
Mu = 9.6932E+008
----
with full section properties:
   b = 450.00
   d = 907.00
   d' = 43.00
   v = 0.0015437
      N = 20792.022
   fc = 33.00
     co (5A.5, TBDY) = 0.002

Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768
   The Shear_factor is considered equal to 1 (pure moment strength)
   From (5.4b), TBDY: cu = 0.0116768
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+ Min(fx, fy) = 0.04178759
   where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
   ----
      fx = 0.02973616
   Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
   af = 0.28545185
   with Unconfined area = ((bmax-2R)^2+ (hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A 4.4.3(6), pf = 2tf/bw = 0.00444444
         bw = 450.00
      effective stress from (A.35), ff,e = 773.4788
   ----
      fy = 0.02973616
   Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
   af = 0.28545185
   with Unconfined area = ((bmax-2R)^2+ (hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A 4.4.3(6), pf = 2tf/bw = 0.00444444
         bw = 450.00
      effective stress from (A.35), ff,e = 773.4788

      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
      fu,f = 840.00
      Ef = 82000.00
       u,f = 0.015
      ase ((5.4d), TBDY) = (ase1*Aext+ ase2*Aint)/Asec = 0.53375773
         ase1 = Max((((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
         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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
         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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
   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 = 2.48363
      psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
         Lstir1 (Length of stirrups along Y) = 2160.00
         Astir1 (stirrups area) = 78.53982
      psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
         Lstir2 (Length of stirrups along Y) = 1568.00
         Astir2 (stirrups area) = 50.26548

```
           ----------------------------------------------------------------
           psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
           psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
              Lstir1 (Length of stirrups along X) = 2560.00
              Astir1 (stirrups area) = 78.53982
           psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
              Lstir2 (Length of stirrups along X) = 1968.00
              Astir2 (stirrups area) = 50.26548
           ----------------------------------------------------------------
              Asec = 562500.00
              s1 = 100.00
              s2 = 250.00
           fywe1 = 694.45
           fywe2 = 694.45
           fce  = 33.00
        From ((5.A5), TBDY), TBDY:  cc = 0.00227274
             c = confinement factor = 1.02727
      y1 = 0.00140044
     sh1 = 0.0044814
    ft1 = 466.8167
    fy1 = 389.0139
     su1 = 0.00512
       using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
       and also multiplied by the shear_factor according to 15.7.1.4, with
       Shear_factor = 1.00
       lo/lou,min = lb/ld = 0.30
        su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
       From table 5A.1, TBDY: esu1_nominal = 0.08,
       For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
       characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
        y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
        with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
        with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
      y2 = 0.00140044
     sh2 = 0.0044814
    ft2 = 466.8167
    fy2 = 389.0139
     su2 = 0.00512
       using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
       and also multiplied by the shear_factor according to 15.7.1.4, with
       Shear_factor = 1.00
       lo/lou,min = lb/lb,min = 0.30
        su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
       From table 5A.1, TBDY: esu2_nominal = 0.08,
       For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
       characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
        y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
        with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
        with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
      yv = 0.00140044
     shv = 0.0044814
    ftv = 466.8167
    fyv = 389.0139
     suv = 0.00512
       using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
       and also multiplied by the shear_factor according to 15.7.1.4, with
       Shear_factor = 1.00
       lo/lou,min = lb/ld = 0.30
        suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
       From table 5A.1, TBDY: esuv_nominal = 0.08,
       considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
       For calculation of esuv_nominal and  yv, shv,ftv,fyv, it is considered
       characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
        y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
        with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
        with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.04446081
```

```
       2 = Asl,com/(b*d)*(fs2/fc) = 0.04446081
       v = Asl,mid/(b*d)*(fsv/fc) = 0.1043468
and confined core properties:
   b = 390.00
   d = 877.00
   d' = 13.00
   fcc (5A.2, TBDY) = 33.90003
     cc (5A.5, TBDY) = 0.00227274
        c = confinement factor = 1.02727
       1 = Asl,ten/(b*d)*(fs1/fc) = 0.05305581
       2 = Asl,com/(b*d)*(fs2/fc) = 0.05305581
       v = Asl,mid/(b*d)*(fsv/fc) = 0.12451875
Case/Assumption: Unconfinesd full section - Steel rupture
   ' satisfies Eq. (4.3)
--->
 v < vs,y2 - LHS eq.(4.5) is satisfied
--->
  su (4.9) = 0.18345742
Mu = MRc (4.14) = 9.6932E+008
   u =    su (4.1) = 6.9132751E-006
---------------------------------------------------------------

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

----------------------------------------------------------------------------
Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
   u = 6.9132751E-006
Mu = 9.6932E+008
----------------------------------------------------------------------------
with full section properties:
   b = 450.00
   d = 907.00
   d' = 43.00
   v = 0.0015437
      N = 20792.022
   fc = 33.00
    co (5A.5, TBDY) = 0.002
   Final value of  cu:  cu* = shear_factor * Max( cu, cc) = 0.0116768
      The Shear_factor is considered equal to 1 (pure moment strength)
      From (5.4b), TBDY:  cu = 0.0116768
        we ((5.4c), TBDY) = ase*  sh,min*fywe/fce+Min(  fx,   fy) = 0.04178759
      where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
      ----------------------------------------------------------------------
         fx = 0.02973616
      Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
      af = 0.28545185
      with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
         bmax = 950.00
         hmax = 750.00
         From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
            bw = 450.00
         effective stress from (A.35), ff,e = 773.4788
      ----------------------------------------------------------------------
         fy = 0.02973616
      Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
      af = 0.28545185
      with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
         bmax = 950.00
         hmax = 750.00
         From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
```

```
        bw = 450.00
        effective stress from (A.35), ff,e = 773.4788
    -----------------------------------------------------------------
        R = 40.00
        Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
        fu,f = 840.00
        Ef = 82000.00
         u,f = 0.015
        ase ((5.4d), TBDY) = (ase1*Aext+ ase2*Aint)/Asec = 0.53375773
            ase1 = Max((((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
            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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
            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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
    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 = 2.48363
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
            Lstir1 (Length of stirrups along Y) = 2160.00
            Astir1 (stirrups area) = 78.53982
        psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
            Lstir2 (Length of stirrups along Y) = 1568.00
            Astir2 (stirrups area) = 50.26548
    -----------------------------------------------------------------
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
            Lstir1 (Length of stirrups along X) = 2560.00
            Astir1 (stirrups area) = 78.53982
        psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
            Lstir2 (Length of stirrups along X) = 1968.00
            Astir2 (stirrups area) = 50.26548
    -----------------------------------------------------------------
        Asec = 562500.00
        s1 = 100.00
        s2 = 250.00
        fywe1 = 694.45
        fywe2 = 694.45
        fce = 33.00
    From ((5.A5), TBDY), TBDY:  cc = 0.00227274
        c = confinement factor = 1.02727
   y1 = 0.00140044
  sh1 = 0.0044814
 ft1 = 466.8167
fy1 = 389.0139
 su1 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
```

and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
     su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and   y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
     with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
     with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.00140044
  sh2 = 0.0044814
 ft2 = 466.8167
 fy2 = 389.0139
  su2 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/lb,min = 0.30
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esu2_nominal = 0.08,
   For calculation of esu2_nominal and   y2, sh2,ft2,fy2, it is considered
   characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00140044
  shv = 0.0044814
 ftv = 466.8167
 fyv = 389.0139
  suv = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.30
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esuv_nominal = 0.08,
   considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
   For calculation of esuv_nominal and   yv, shv,ftv,fyv, it is considered
   characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.04446081
   2 = Asl,com/(b*d)*(fs2/fc) = 0.04446081
  v = Asl,mid/(b*d)*(fsv/fc) = 0.1043468
and confined core properties:
  b = 390.00
  d = 877.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.90003
   cc (5A.5, TBDY) = 0.00227274
    c = confinement factor = 1.02727
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.05305581
   2 = Asl,com/(b*d)*(fs2/fc) = 0.05305581
   v = Asl,mid/(b*d)*(fsv/fc) = 0.12451875
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.18345742
Mu = MRc (4.14) = 9.6932E+008
 u =   su (4.1) = 6.9132751E-006

Calculation of ratio lb/ld

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

-------------------------------------------------------------------------
Calculation of ultimate curvature  u according to 4.1, Biskinis/Fardis 2013:
  u = 6.9132751E-006
Mu = 9.6932E+008
-------------------------------------------------------------------------
with full section properties:
  b = 450.00
  d = 907.00
  d' = 43.00
  v = 0.0015437
    N = 20792.022
  fc = 33.00
  co (5A.5, TBDY) = 0.002
  Final value of  cu:  cu* = shear_factor * Max( cu, cc) = 0.0116768
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY:  cu = 0.0116768
       we ((5.4c), TBDY) = ase*  sh,min*fywe/fce+Min(  fx,  fy) = 0.04178759
     where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
     ---------------------------------------------------------------
       fx = 0.02973616
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
        bmax = 950.00
        hmax = 750.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
           bw = 450.00
        effective stress from (A.35), ff,e = 773.4788
     ---------------------------------------------------------------
       fy = 0.02973616
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
        bmax = 950.00
        hmax = 750.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
           bw = 450.00
        effective stress from (A.35), ff,e = 773.4788
     ---------------------------------------------------------------
       R = 40.00
       Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
       fu,f = 840.00
       Ef = 82000.00
        u,f = 0.015
       ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
          ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
          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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
          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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
   Lstir1 (Length of stirrups along Y) = 2160.00
   Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
   Lstir2 (Length of stirrups along Y) = 1568.00
   Astir2 (stirrups area) = 50.26548

----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
   Lstir1 (Length of stirrups along X) = 2560.00
   Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
   Lstir2 (Length of stirrups along X) = 1968.00
   Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00227274
   c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
  with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
  with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
  suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esuv_nominal = 0.08,
  considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
  For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
  characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
  with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.04446081
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.04446081
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.1043468
and confined core properties:
  b = 390.00
  d = 877.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.90003
  εcc (5A.5, TBDY) = 0.00227274
    αc = confinement factor = 1.02727
    ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.05305581
    ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05305581
    ωv = Asl,mid/(b*d)*(fsv/fc) = 0.12451875
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
ωv < ωs,y2 - LHS eq.(4.5) is satisfied
--->
εsu (4.9) = 0.18345742
Mu = MRc (4.14) = 9.6932E+008
φu = φsu (4.1) = 6.9132751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 6.9132751E-006
Mu = 9.6932E+008
----
with full section properties:
  b = 450.00
  d = 907.00
  d' = 43.00
  ν = 0.0015437
    N = 20792.022
  fc = 33.00
  εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.0116768
    The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: cu = 0.0116768
  we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.04178759
where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

----

  fx = 0.02973616
Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
af = 0.28545185
with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
  bmax = 950.00
  hmax = 750.00
  From EC8 A 4.4.3(6), pf = 2tf/bw = 0.00444444
    bw = 450.00
  effective stress from (A.35), ff,e = 773.4788

----

  fy = 0.02973616
Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
af = 0.28545185
with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
  bmax = 950.00
  hmax = 750.00
  From EC8 A 4.4.3(6), pf = 2tf/bw = 0.00444444
    bw = 450.00
  effective stress from (A.35), ff,e = 773.4788

  R = 40.00
  Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
  fu,f = 840.00
  Ef = 82000.00
  u,f = 0.015
  ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
    ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
    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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
    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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
  psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
    Lstir1 (Length of stirrups along Y) = 2160.00
    Astir1 (stirrups area) = 78.53982
  psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
    Lstir2 (Length of stirrups along Y) = 1568.00
    Astir2 (stirrups area) = 50.26548

----

  psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078

psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
    Lstir1 (Length of stirrups along X) = 2560.00
    Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
    Lstir2 (Length of stirrups along X) = 1968.00
    Astir2 (stirrups area) = 50.26548

    Asec = 562500.00
    s1 = 100.00
    s2 = 250.00
    fywe1 = 694.45
    fywe2 = 694.45
    fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00227274
    c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
   su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esu1_nominal = 0.08,
  For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
  characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
   y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
   with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
   with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/lb,min = 0.30
   su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esu2_nominal = 0.08,
  For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
  characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
   y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
   with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
   with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
   suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esuv_nominal = 0.08,
  considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
  For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
  characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
   y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
   with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
   with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04446081
2 = Asl,com/(b*d)*(fs2/fc) = 0.04446081
v = Asl,mid/(b*d)*(fsv/fc) = 0.1043468

and confined core properties:
   b = 390.00
   d = 877.00
   d' = 13.00
   fcc (5A.2, TBDY) = 33.90003
     cc (5A.5, TBDY) = 0.00227274
        c = confinement factor = 1.02727
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.05305581
     2 = Asl,com/(b*d)*(fs2/fc) = 0.05305581
     v = Asl,mid/(b*d)*(fsv/fc) = 0.12451875
Case/Assumption: Unconfinesd full section - Steel rupture
   ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
  su (4.9) = 0.18345742
Mu = MRc (4.14) = 9.6932E+008
  u =   su (4.1) = 6.9132751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.8004E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.8004E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
   VCol0 = 1.8004E+006
   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 = 33.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
   M/Vd = 2.00
      Mu = 1.22911
      Vu = 5.4210109E-020
   d = 0.8*h = 760.00
   Nu = 20792.022
   Ag = 427500.00
   From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 1.1114E+006
   where:
   Vs,jacket = Vs,j1 + Vs,j2 = 977392.20
   Vs,j1 = 314161.779 is calculated for section web jacket, with:
      d = 360.00
      Av = 157079.633
      fy = 555.56
      s = 100.00
   Vs,j1 is multiplied by   Col,j1 = 1.00
      s/d = 0.27777778
   Vs,j2 = 663230.422 is calculated for section flange jacket, with:
      d = 760.00
      Av = 157079.633
      fy = 555.56
      s = 100.00
   Vs,j2 is multiplied by   Col,j2 = 1.00
      s/d = 0.13157895
   Vs,core = Vs,c1 + Vs,c2 = 134042.359
   Vs,c1 = 0.00 is calculated for section web core, with:
      d = 200.00
      Av = 100530.965

fy = 555.56
      s = 250.00
  Vs,c1 is multiplied by   Col,c1 = 0.00
      s/d = 1.25
  Vs,c2 = 134042.359 is calculated for section flange core, with:
      d = 600.00
      Av = 100530.965
      fy = 555.56
      s = 250.00
  Vs,c2 is multiplied by   Col,c2 = 1.00
      s/d = 0.41666667
  Vf ((11-3)-(11.4), ACI 440) = 594992.00
      f = 0.95, for fully-wrapped sections
  wf/sf = 1 (FRP strips adjacent to one another).
  In (11.3) sin + cos is replaced with (cot +cota)sina which is more a generalised expression,
  where   is the angle of the crack direction (see KANEPE).
  This later relation, considered as a function Vf(,), is implemented for every different fiber orientation ai,
  as well as for 2 crack directions, = 45° and = -45° to take into consideration the cyclic seismic loading.
  orientation 1:   1 = b1 + 90° = 90.00
  Vf = Min(|Vf(45, 1)|,|Vf(-45,a1)|), with:
  total thickness per orientation, tf1 = NL*t/NoDir = 1.00
  dfv = d (figure 11.2, ACI 440) = 907.00
  ffe ((11-5), ACI 440) = 328.00
      Ef = 82000.00
       fe = 0.004, from (11.6a), ACI 440
         with fu = 0.009
  From (11-11), ACI 440: Vs + Vf <= 1.3051E+006
      bw = 450.00

Calculation of Shear Strength at edge 2, Vr2 = 1.8004E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 1.8004E+006
  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 = 33.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
     Mu = 1.22911
     Vu = 5.4210109E-020
  d = 0.8*h = 760.00
  Nu = 20792.022
  Ag = 427500.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 1.1114E+006
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 977392.20
  Vs,j1 = 314161.779 is calculated for section web jacket, with:
      d = 360.00
      Av = 157079.633
      fy = 555.56
      s = 100.00
  Vs,j1 is multiplied by   Col,j1 = 1.00
      s/d = 0.27777778
  Vs,j2 = 663230.422 is calculated for section flange jacket, with:
      d = 760.00
      Av = 157079.633
      fy = 555.56
      s = 100.00
  Vs,j2 is multiplied by   Col,j2 = 1.00
      s/d = 0.13157895
  Vs,core = Vs,c1 + Vs,c2 = 134042.359
  Vs,c1 = 0.00 is calculated for section web core, with:
      d = 200.00

Av = 100530.965
fy = 555.56
s = 250.00
Vs,c1 is multiplied by   Col,c1 = 0.00
s/d = 1.25
Vs,c2 = 134042.359 is calculated for section flange core, with:
d = 600.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs,c2 is multiplied by   Col,c2 = 1.00
s/d = 0.41666667
Vf ((11-3)-(11.4), ACI 440) = 594992.00
f = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sin + cos is replaced with (cot +cota)sina which is more a generalised expression,
where   is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(,), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, =45° and =-45° to take into consideration the cyclic seismic loading.
orientation 1:   1 = b1 + 90° = 90.00
Vf = Min(|Vf(45, 1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.00
dfv = d (figure 11.2, ACI 440) = 907.00
ffe ((11-5), ACI 440) = 328.00
Ef = 82000.00
fe = 0.004, from (11.6a), ACI 440
with fu = 0.009
From (11-11), ACI 440: Vs + Vf <= 1.3051E+006
bw = 450.00

End Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column JTC1 of floor 1
At local axis: 3
Integration Section: (a)
Section Type: rcjtcs

Constant Properties

Knowledge Factor,   = 0.80
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 Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member

Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lb/ld = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

Stepwise Properties

Bending Moment, M = -1.5449E+007
Shear Force, V2 = -5103.636
Shear Force, V3 = 67.97343
Axial Force, F = -21366.38
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1539.38
     -Compression: Asl,com = 1539.38
         -Middle: Asl,mid = 3612.832
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,jacket = 1231.504
     -Compression: Asl,com,jacket = 1231.504
         -Middle: Asl,mid,jacket = 2689.203
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,core = 307.8761
     -Compression: Asl,com,core = 307.8761
         -Middle: Asl,mid,core = 923.6282
Mean Diameter of Tension Reinforcement, DbL = 16.57143

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity   u,R = 1.0* u = 0.0024396
   u =   y +   p = 0.0024396

 - Calculation of   y -
----
  y = (My*Ls/3)/Eleff = 0.0024396 ((4.29),Biskinis Phd))
  My = 6.7427E+008
  Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3027.037
  From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 2.7887E+014
     factor = 0.30
        Ag = 562500.00
        Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
        N = 21366.38
     Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 9.2958E+014

Calculation of Yielding Moment My

Calculation of   y and My according to Annex 7   -
----
  y = Min(y_ten, y_com)

y_ten = 2.3114142E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 311.2112
    d = 907.00
     y = 0.25776728
     A = 0.01656315
     B = 0.00875431
      with pt = 0.0037716
          pc = 0.0037716
          pv = 0.00885172
          N = 21366.38
          b = 450.00
           " = 0.04740904
  y_comp = 9.5688004E-006
 with fc* (12.3, (ACI 440)) = 33.31497
     fc = 33.00
     fl = 0.5419822
     b = bmax = 950.00
     h = hmax = 750.00
     Ag = 0.5625
        g = pt + pc + pv = 0.01639493
        rc = 40.00
        Ae/Ac = 0.29742395
        Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
     effective strain from (12.5) and (12.12), efe = 0.004
      fu = 0.009
     Ef = 82000.00
     Ec = 26999.444
      y = 0.25591301
     A = 0.01627709
     B = 0.0085861
      with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

 - Calculation of p -

From table 10-8: p = 0.00
with:
 - Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
   shear control ratio VyE/VColOE = 0.3589236
   d = d_external = 907.00
   s = s_external = 0.00
 - t =   s1 +   s2 + 2*tf/bw*(ffe/fs) = 0.00690186
   jacket: s1 = Av1*Lstir1/(s1*Ag) = 0.00357443
          Av1 = 78.53982, is the area of every stirrup parallel to loading (shear) direction
          Lstir1 = 2560.00, is the total Length of all stirrups parallel to loading (shear) direction
          s1 = 100.00
   core: s2 = Av2*Lstir2/(s2*Ag) = 0.00070345
          Av2 = 50.26548, is the area of every stirrup parallel to loading (shear) direction
          Lstir2 = 1968.00, 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 = 21366.38
    Ag = 562500.00
    f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 33.00
    fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein =
555.56
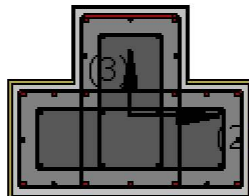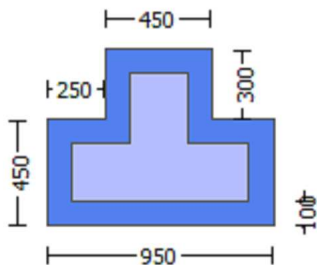   fytE = (fy_ext_Trans_Reinf* s1+fy_int_Trans_Reinf* s2)/(s1+ s2) = 555.56
pl = Area_Tot_Long_Rein/(b*d) = 0.01639493

```
  b =  450.00
  d =  907.00
    f'cE =  33.00
--------------------------------------------------------------
End Of Calculation of Chord Rotation Capacity for element: column JTC1 of floor 1
At local axis: 3
Integration Section: (a)


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

Calculation No. 5

column C1, Floor 1

Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (2)


```
Start Of Calculation of Shear Capacity for element: column JTC1 of floor 1
At local axis: 2
Integration Section: (b)
Section Type: rcjtcs

Constant Properties
--------------------------------------------------------------
Knowledge Factor,   = 0.80
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 Primary Member: Concrete Strength, fc = fc_lower_bound =  25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound =  500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
```

New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
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 = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
##
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min =lb/ld = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -1.5449E+007
Shear Force, Va = -5103.636
EDGE -B-
Bending Moment, Mb = 135025.377
Shear Force, Vb = 5103.636
BOTH EDGES
Axial Force, F = -21366.38
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
   -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 1539.38
   -Compression: Asl,com = 1539.38
      -Middle: Asl,mid = 3612.832
Mean Diameter of Tension Reinforcement, DbL,ten = 16.57143

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 1.5677E+006
Vn ((10.3), ASCE 41-17) = knl*VColO = 1.5677E+006
   VCol = 1.5677E+006

knl = 1.00
　　displacement_ductility_demand = 0.03493947

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 = 2.00
　　Mu = 135025.377
　　Vu = 5103.636
　d = 0.8*h = 760.00
　Nu = 21366.38
　Ag = 427500.00
　From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 1.0003E+006
　where:
　Vs,jacket = Vs,j1 + Vs,j2 = 879645.943
　Vs,j1 = 282743.339 is calculated for section web jacket, with:
　　d = 360.00
　　Av = 157079.633
　　fy = 500.00
　　s = 100.00
　Vs,j1 is multiplied by　Col,j1 = 1.00
　　s/d = 0.27777778
　Vs,j2 = 596902.604 is calculated for section flange jacket, with:
　　d = 760.00
　　Av = 157079.633
　　fy = 500.00
　　s = 100.00
　Vs,j2 is multiplied by　Col,j2 = 1.00
　　s/d = 0.13157895
　Vs,core = Vs,c1 + Vs,c2 = 120637.158
　Vs,c1 = 0.00 is calculated for section web core, with:
　　d = 200.00
　　Av = 100530.965
　　fy = 500.00
　　s = 250.00
　Vs,c1 is multiplied by　Col,c1 = 0.00
　　s/d = 1.25
　Vs,c2 = 120637.158 is calculated for section flange core, with:
　　d = 600.00
　　Av = 100530.965
　　fy = 500.00
　　s = 250.00
　Vs,c2 is multiplied by　Col,c2 = 1.00
　　s/d = 0.41666667
　Vf ((11-3)-(11.4), ACI 440) = 594992.00
　　ψf = 0.95, for fully-wrapped sections
　wf/sf = 1 (FRP strips adjacent to one another).
　In (11.3) sinβ + cosβ is replaced with (cotθ+cotα)sinα which is more a generalised expression,
　where θ is the angle of the crack direction (see KANEPE).
　This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
　as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
　orientation 1:　α1 = b1 + 90° = 90.00
　Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
　total thickness per orientation, tf1 = NL*t/NoDir = 1.00
　dfv = d (figure 11.2, ACI 440) = 907.00
　ffe ((11-5), ACI 440) = 328.00
　　Ef = 82000.00
　　εfe = 0.004, from (11.6a), ACI 440
　　　with εfu = 0.009
　From (11-11), ACI 440: Vs + Vf <= 1.1360E+006
　　bw = 450.00

----

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 = 8.4476953E-006
 y = (My*Ls/3)/EIeff = 0.00024178 ((4.29),Biskinis Phd))
  My = 6.7427E+008
  Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 300.00
  From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 2.7887E+014
     factor = 0.30
        Ag = 562500.00
        Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
        N = 21366.38
     Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 9.2958E+014

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7 -
----
  y = Min(y_ten, y_com)
  y_ten = 2.3114142E-006
  with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 311.2112
     d = 907.00
      y = 0.25776728
     A = 0.01656315
     B = 0.00875431
      with pt = 0.0037716
         pc = 0.0037716
         pv = 0.00885172
         N = 21366.38
         b = 450.00
          " = 0.04740904
   y_comp = 9.5688004E-006
  with fc* (12.3, (ACI 440)) = 33.31497
     fc = 33.00
     fl = 0.5419822
     b = bmax = 950.00
     h = hmax = 750.00
     Ag = 0.5625
        g = pt + pc + pv = 0.01639493
        rc = 40.00
        Ae/Ac = 0.29742395
        Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
      effective strain from (12.5) and (12.12), efe = 0.004
       fu = 0.009
      Ef = 82000.00
     Ec = 26999.444
      y = 0.25591301
     A = 0.01627709
     B = 0.0085861
      with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

End Of Calculation of Shear Capacity for element: column JTC1 of floor 1
At local axis: 2
Integration Section: (b)

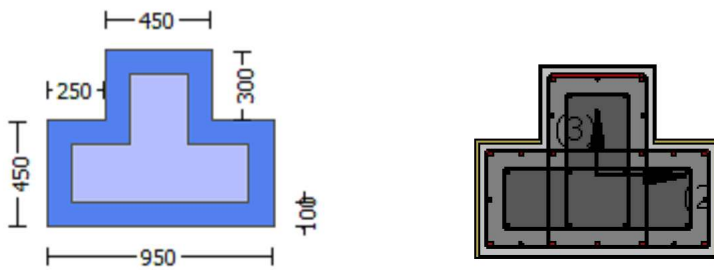
column C1, Floor 1

Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (u)

Edge: End

Local Axis: (2)

Start Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcjtcs

Constant Properties

Knowledge Factor,   = 0.80
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
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 = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
##
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00

Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.02727
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = -2.5087409E-020
EDGE -B-
Shear Force, Vb = 2.5087409E-020
BOTH EDGES
Axial Force, F = -20792.022
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
    -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 1539.38
    -Compression: Asl,com = 2475.575
      -Middle: Asl,mid = 2676.637

Calculation of Shear Capacity ratio , Ve/Vr = 0.44505685
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 632982.444
with
Mpr1 = Max(Mu1+ , Mu1-) = 9.4947E+008
  Mu1+ = 6.7087E+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- = 9.4947E+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-) = 9.4947E+008
  Mu2+ = 6.7087E+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- = 9.4947E+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 = 8.5351751E-006
Mu = 6.7087E+008
----
with full section properties:
  b = 950.00
  d = 707.00
  d' = 43.00
  v = 0.00093808
    N = 20792.022
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.0116768
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.04178759
    where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----
      fx = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788
    ----
      fy = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788

      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
      fu,f = 840.00
      Ef = 82000.00
       u,f = 0.015
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
        ase1 = Max((((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
        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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
        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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363

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 = 2.48363
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
   Lstir1 (Length of stirrups along Y) = 2160.00
   Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
   Lstir2 (Length of stirrups along Y) = 1568.00
   Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
   Lstir1 (Length of stirrups along X) = 2560.00
   Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
   Lstir2 (Length of stirrups along X) = 1968.00
   Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00227274
   c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
  su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esu1_nominal = 0.08,
  For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
  characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
  with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
  with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/lb,min = 0.30
  su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esu2_nominal = 0.08,
  For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
  characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
  with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
  with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
 suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
 y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
 with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
 with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.02701806
2 = Asl,com/(b*d)*(fs2/fc) = 0.04344945
v = Asl,mid/(b*d)*(fsv/fc) = 0.04697834
and confined core properties:
 b = 890.00
 d = 677.00
 d' = 13.00
 fcc (5A.2, TBDY) = 33.90003
  cc (5A.5, TBDY) = 0.00227274
   c = confinement factor = 1.02727
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.03011747
  2 = Asl,com/(b*d)*(fs2/fc) = 0.04843381
  v = Asl,mid/(b*d)*(fsv/fc) = 0.05236752
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.15152684
Mu = MRc (4.14) = 6.7087E+008
 u = su (4.1) = 8.5351751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 u = 9.2428803E-006
Mu = 9.4947E+008
----
with full section properties:
 b = 450.00
 d = 707.00
 d' = 43.00
 v = 0.00198039
   N = 20792.022
 fc = 33.00
  co (5A.5, TBDY) = 0.002
 Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768
   The Shear_factor is considered equal to 1 (pure moment strength)
   From (5.4b), TBDY: cu = 0.0116768
    we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx,   fy) = 0.04178759
   where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
   ----
    fx = 0.02973616
   Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
   af = 0.28545185
   with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
    bmax = 950.00
    hmax = 750.00

From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
  bw = 450.00
effective stress from (A.35), ff,e = 773.4788

----

 fy = 0.02973616
Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
af = 0.28545185
with Unconfined area = ((bmax-2R)^2+ (hmax-2R)^2)/3 = 160566.667
  bmax = 950.00
  hmax = 750.00
  From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
    bw = 450.00
  effective stress from (A.35), ff,e = 773.4788

 R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
fu,f = 840.00
Ef = 82000.00
 u,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ ase2*Aint)/Asec = 0.53375773
  ase1 = Max((((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
  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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
  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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
  psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
    Lstir1 (Length of stirrups along Y) = 2160.00
    Astir1 (stirrups area) = 78.53982
  psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
    Lstir2 (Length of stirrups along Y) = 1568.00
    Astir2 (stirrups area) = 50.26548

----

  psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
  psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
    Lstir1 (Length of stirrups along X) = 2560.00
    Astir1 (stirrups area) = 78.53982
  psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
    Lstir2 (Length of stirrups along X) = 1968.00
    Astir2 (stirrups area) = 50.26548

  Asec = 562500.00
  s1 = 100.00
  s2 = 250.00

```
        fywe1 = 694.45
        fywe2 = 694.45
        fce  = 33.00
    From ((5.A5), TBDY), TBDY:  cc = 0.00227274
        c  = confinement factor = 1.02727
  y1 = 0.00140044
 sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
 su1 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.30
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esu1_nominal = 0.08,
   For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
   characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
 y2 = 0.00140044
 sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
 su2 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/lb,min = 0.30
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esu2_nominal = 0.08,
   For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
   characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
 yv = 0.00140044
 shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
 suv = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.30
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esuv_nominal = 0.08,
   considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
   For calculation of esuv_nominal and  yv, shv,ftv,fyv, it is considered
   characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.09172662
  2 = Asl,com/(b*d)*(fs2/fc) = 0.05703813
  v = Asl,mid/(b*d)*(fsv/fc) = 0.0991765
and confined core properties:
  b = 390.00
  d = 677.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.90003
   cc (5A.5, TBDY) = 0.00227274
      c  = confinement factor = 1.02727
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.11052844
    2 = Asl,com/(b*d)*(fs2/fc) = 0.06872961
    v = Asl,mid/(b*d)*(fsv/fc) = 0.11950537
```

Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.21649239
Mu = MRc (4.14) = 9.4947E+008
  u =   su (4.1) = 9.2428803E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 8.5351751E-006
Mu = 6.7087E+008
----
with full section properties:
  b = 950.00
  d = 707.00
  d' = 43.00
  v = 0.00093808
    N = 20792.022
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: cu = 0.0116768
       we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx,   fy) = 0.04178759
     where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
     ----
       fx = 0.02973616
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
        bmax = 950.00
        hmax = 750.00
        From EC8 A4.4.3(6), pf = 2tf/bw = 0.00444444
           bw = 450.00
        effective stress from (A.35), ff,e = 773.4788
     ----
       fy = 0.02973616
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
        bmax = 950.00
        hmax = 750.00
        From EC8 A4.4.3(6), pf = 2tf/bw = 0.00444444
           bw = 450.00
        effective stress from (A.35), ff,e = 773.4788

        R = 40.00
        Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
        fu,f = 840.00
        Ef = 82000.00
         u,f = 0.015
        ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
           ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
           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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
   Lstir1 (Length of stirrups along Y) = 2160.00
   Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
   Lstir2 (Length of stirrups along Y) = 1568.00
   Astir2 (stirrups area) = 50.26548
       ----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
   Lstir1 (Length of stirrups along X) = 2560.00
   Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
   Lstir2 (Length of stirrups along X) = 1968.00
   Astir2 (stirrups area) = 50.26548

   Asec = 562500.00
   s1 = 100.00
   s2 = 250.00
 fywe1 = 694.45
 fywe2 = 694.45
 fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00227274
   c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
  su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esu1_nominal = 0.08,
  For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
  characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
   y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
   with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
   with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814

ft2 = 466.8167
fy2 = 389.0139
 su2 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/lb,min = 0.30
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esu2_nominal = 0.08,
   For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
   characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00140044
  shv = 0.0044814
 ftv = 466.8167
 fyv = 389.0139
  suv = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.30
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esuv_nominal = 0.08,
   considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
   For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
   characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.02701806
  2 = Asl,com/(b*d)*(fs2/fc) = 0.04344945
  v = Asl,mid/(b*d)*(fsv/fc) = 0.04697834
and confined core properties:
  b = 890.00
  d = 677.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.90003
   cc (5A.5, TBDY) = 0.00227274
     c = confinement factor = 1.02727
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.03011747
   2 = Asl,com/(b*d)*(fs2/fc) = 0.04843381
   v = Asl,mid/(b*d)*(fsv/fc) = 0.05236752
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.15152684
Mu = MRc (4.14) = 6.7087E+008
  u =   su (4.1) = 8.5351751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 9.2428803E-006
Mu = 9.4947E+008

```
-----------------------------------------------------------------------------------
with full section properties:
  b = 450.00
  d = 707.00
  d' = 43.00
  v = 0.00198039
    N = 20792.022
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of  cu:  cu* = shear_factor * Max( cu, cc) = 0.0116768
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY:  cu = 0.0116768
      we ((5.4c), TBDY) = ase*  sh,min*fywe/fce+Min(  fx,   fy) = 0.04178759
    where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ------------------------------------------------------------------
      fx = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788
    ------------------------------------------------------------------
      fy = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788
    ------------------------------------------------------------------
      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
      fu,f = 840.00
      Ef = 82000.00
       u,f = 0.015
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
        ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
        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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
        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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
    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 = 2.48363
    psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
       Lstir1 (Length of stirrups along Y) = 2160.00
       Astir1 (stirrups area) = 78.53982
    psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
       Lstir2 (Length of stirrups along Y) = 1568.00
       Astir2 (stirrups area) = 50.26548

------------------------------------------------------------------
    psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
    psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
       Lstir1 (Length of stirrups along X) = 2560.00
       Astir1 (stirrups area) = 78.53982
    psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
       Lstir2 (Length of stirrups along X) = 1968.00
       Astir2 (stirrups area) = 50.26548

------------------------------------------------------------------
       Asec = 562500.00
       s1 = 100.00
       s2 = 250.00
     fywe1 = 694.45
     fywe2 = 694.45
     fce  = 33.00
   From ((5.A5), TBDY), TBDY:  cc = 0.00227274
       c  = confinement factor = 1.02727
  y1 = 0.00140044
  sh1 = 0.0044814
 ft1 = 466.8167
 fy1 = 389.0139
  su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
     su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
     with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
     with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.00140044
  sh2 = 0.0044814
 ft2 = 466.8167
 fy2 = 389.0139
  su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.30
     su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
     with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
     with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00140044
  shv = 0.0044814
 ftv = 466.8167
 fyv = 389.0139
  suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
```

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and   yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
  with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09172662
2 = Asl,com/(b*d)*(fs2/fc) = 0.05703813
v = Asl,mid/(b*d)*(fsv/fc) = 0.0991765
and confined core properties:
  b = 390.00
  d = 677.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.90003
   cc (5A.5, TBDY) = 0.00227274
     c = confinement factor = 1.02727
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.11052844
  2 = Asl,com/(b*d)*(fs2/fc) = 0.06872961
  v = Asl,mid/(b*d)*(fsv/fc) = 0.11950537
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.21649239
Mu = MRc (4.14) = 9.4947E+008
 u =   su (4.1) = 9.2428803E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.4223E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.4223E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 1.4223E+006
  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 = 33.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
    Mu = 1533.833
    Vu = 2.5087409E-020
  d = 0.8*h = 600.00
  Nu = 20792.022
  Ag = 337500.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 936062.473
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 837764.743
  Vs,j1 = 523602.964 is calculated for section web jacket, with:
    d = 600.00
    Av = 157079.633
    fy = 555.56
    s = 100.00
  Vs,j1 is multiplied by   Col,j1 = 1.00
    s/d = 0.16666667

Vs,j2 = 314161.779 is calculated for section flange jacket, with:
  d = 360.00
  Av = 157079.633
  fy = 555.56
  s = 100.00
 Vs,j2 is multiplied by   Col,j2 = 1.00
   s/d = 0.27777778
 Vs,core = Vs,c1 + Vs,c2 = 98297.73
 Vs,c1 = 98297.73 is calculated for section web core, with:
  d = 440.00
  Av = 100530.965
  fy = 555.56
  s = 250.00
 Vs,c1 is multiplied by   Col,c1 = 1.00
   s/d = 0.56818182
 Vs,c2 = 0.00 is calculated for section flange core, with:
  d = 200.00
  Av = 100530.965
  fy = 555.56
  s = 250.00
 Vs,c2 is multiplied by   Col,c2 = 0.00
   s/d = 1.25
 Vf ((11-3)-(11.4), ACI 440) = 463792.00
   f = 0.95, for fully-wrapped sections
 wf/sf = 1 (FRP strips adjacent to one another).
 In (11.3) sin + cos is replaced with (cot +cota)sina which is more a generalised expression,
 where is the angle of the crack direction (see KANEPE).
 This later relation, considered as a function Vf(,), is implemented for every different fiber orientation ai,
 as well as for 2 crack directions, =45° and =-45° to take into consideration the cyclic seismic loading.
 orientation 1: 1 = b1 + 90° = 90.00
 Vf = Min(|Vf(45, 1)|,|Vf(-45,a1)|), with:
 total thickness per orientation, tf1 = NL*t/NoDir = 1.00
 dfv = d (figure 11.2, ACI 440) = 707.00
 ffe ((11-5), ACI 440) = 328.00
   Ef = 82000.00
    fe = 0.004, from (11.6a), ACI 440
     with fu = 0.009
 From (11-11), ACI 440: Vs + Vf <= 1.0304E+006
   bw = 450.00

Calculation of Shear Strength at edge 2, Vr2 = 1.4223E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
 VCol0 = 1.4223E+006
 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 = 33.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
 M/Vd = 2.00
   Mu = 1533.833
   Vu = 2.5087409E-020
 d = 0.8*h = 600.00
 Nu = 20792.022
 Ag = 337500.00
 From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 936062.473
 where:
 Vs,jacket = Vs,j1 + Vs,j2 = 837764.743
 Vs,j1 = 523602.964 is calculated for section web jacket, with:
  d = 600.00
  Av = 157079.633
  fy = 555.56
  s = 100.00
 Vs,j1 is multiplied by   Col,j1 = 1.00

s/d = 0.16666667
Vs,j2 = 314161.779 is calculated for section flange jacket, with:
    d = 360.00
    Av = 157079.633
    fy = 555.56
    s = 100.00
Vs,j2 is multiplied by   Col,j2 = 1.00
    s/d = 0.27777778
Vs,core = Vs,c1 + Vs,c2 = 98297.73
Vs,c1 = 98297.73 is calculated for section web core, with:
    d = 440.00
    Av = 100530.965
    fy = 555.56
    s = 250.00
Vs,c1 is multiplied by   Col,c1 = 1.00
    s/d = 0.56818182
Vs,c2 = 0.00 is calculated for section flange core, with:
    d = 200.00
    Av = 100530.965
    fy = 555.56
    s = 250.00
Vs,c2 is multiplied by   Col,c2 = 0.00
    s/d = 1.25
Vf ((11-3)-(11.4), ACI 440) = 463792.00
    φf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sin α + cos α is replaced with (cot θ +cotα)sinα which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ, α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1:   α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45, α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.00
dfv = d (figure 11.2, ACI 440) = 707.00
ffe ((11-5), ACI 440) = 328.00
    Ef = 82000.00
    εfe = 0.004, from (11.6a), ACI 440
        with εfu = 0.009
From (11-11), ACI 440: Vs + Vf <= 1.0304E+006
    bw = 450.00

End Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjtcs

Constant Properties

Knowledge Factor, γ = 0.80
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444

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 = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
###
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.02727
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = 5.4210109E-020
EDGE -B-
Shear Force, Vb = -5.4210109E-020
BOTH EDGES
Axial Force, F = -20792.022
Longitudinal Reinforcement Area Distribution (in 2 divisions)
       -Tension: Aslt = 0.00
    -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1539.38
     -Compression: Asl,com = 1539.38
         -Middle: Asl,mid = 3612.832

Calculation of Shear Capacity ratio , Ve/Vr = 0.3589236
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 646212.952
with
Mpr1 = Max(Mu1+ , Mu1-) = 9.6932E+008
  Mu1+ = 9.6932E+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- = 9.6932E+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-) = 9.6932E+008

Mu2+ = 9.6932E+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- = 9.6932E+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 = 6.9132751E-006
Mu = 9.6932E+008
----
with full section properties:
  b = 450.00
  d = 907.00
  d' = 43.00
  ν = 0.0015437
    N = 20792.022
  fc = 33.00
  εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.0116768
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.0116768
      ωwe ((5.4c), TBDY) = ρse*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.04178759
    where ωf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

      ωfx = 0.02973616
    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
    αf = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788

      ωfy = 0.02973616
    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
    αf = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788

      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
      fu,f = 840.00
      Ef = 82000.00
      εu,f = 0.015
      ρse ((5.4d), TBDY) = (ρse1*Aext+ρse2*Aint)/Asec = 0.53375773
        ρse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
        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 = 464100.00 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 = 395025.00 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 = 173066.667 is the unconfined external core area which is equal to Σbi2/6 as defined at (A.2).
      ρse2 (>=ρse1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773

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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548

----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00227274
c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered

characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
   with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
   with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
 yv = 0.00140044
 shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
 suv = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
   suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esuv_nominal = 0.08,
  considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
  For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
  characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
   with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
   with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.04446081
  2 = Asl,com/(b*d)*(fs2/fc) = 0.04446081
  v = Asl,mid/(b*d)*(fsv/fc) = 0.1043468
and confined core properties:
 b = 390.00
 d = 877.00
 d' = 13.00
 fcc (5A.2, TBDY) = 33.90003
  cc (5A.5, TBDY) = 0.00227274
   c = confinement factor = 1.02727
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.05305581
  2 = Asl,com/(b*d)*(fs2/fc) = 0.05305581
  v = Asl,mid/(b*d)*(fsv/fc) = 0.12451875
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.18345742
Mu = MRc (4.14) = 9.6932E+008
 u = su (4.1) = 6.9132751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 u = 6.9132751E-006
Mu = 9.6932E+008
----
with full section properties:
 b = 450.00
 d = 907.00
 d' = 43.00
 v = 0.0015437
  N = 20792.022
 fc = 33.00
  co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768

The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0116768
   we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.04178759
where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----
   fx = 0.02973616
Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
af = 0.28545185
with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
   bmax = 950.00
   hmax = 750.00
   From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
      bw = 450.00
   effective stress from (A.35), ff,e = 773.4788
----
   fy = 0.02973616
Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
af = 0.28545185
with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
   bmax = 950.00
   hmax = 750.00
   From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
      bw = 450.00
   effective stress from (A.35), ff,e = 773.4788

   R = 40.00
   Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
   fu,f = 840.00
   Ef = 82000.00
    u,f = 0.015
   ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
      ase1 = Max((((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
      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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
      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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
 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 = 2.48363
   psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
      Lstir1 (Length of stirrups along Y) = 2160.00
      Astir1 (stirrups area) = 78.53982
   psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
      Lstir2 (Length of stirrups along Y) = 1568.00
      Astir2 (stirrups area) = 50.26548

```
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
            Lstir1 (Length of stirrups along X) = 2560.00
            Astir1 (stirrups area) = 78.53982
        psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
            Lstir2 (Length of stirrups along X) = 1968.00
            Astir2 (stirrups area) = 50.26548
    ------------------------------------------------------------------
            Asec = 562500.00
            s1 = 100.00
            s2 = 250.00
        fywe1 = 694.45
        fywe2 = 694.45
        fce  = 33.00
    From ((5.A5), TBDY), TBDY:  cc = 0.00227274
        c = confinement factor = 1.02727
  y1 = 0.00140044
  sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
 su1 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.30
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esu1_nominal = 0.08,
   For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
   characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.00140044
  sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
 su2 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/lb,min = 0.30
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esu2_nominal = 0.08,
   For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
   characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00140044
  shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
 suv = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.30
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esuv_nominal = 0.08,
   considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
   For calculation of esuv_nominal and  yv, shv,ftv,fyv, it is considered
   characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.04446081
  2 = Asl,com/(b*d)*(fs2/fc) = 0.04446081
```

v = Asl,mid/(b*d)*(fsv/fc) = 0.1043468
and confined core properties:
  b = 390.00
  d = 877.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.90003
    εcc (5A.5, TBDY) = 0.00227274
      c = confinement factor = 1.02727
    ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.05305581
    ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05305581
    v = Asl,mid/(b*d)*(fsv/fc) = 0.12451875
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 εsu (4.9) = 0.18345742
Mu = MRc (4.14) = 9.6932E+008
  φu =   φsu (4.1) = 6.9132751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 6.9132751E-006
Mu = 9.6932E+008
----
with full section properties:
  b = 450.00
  d = 907.00
  d' = 43.00
  v = 0.0015437
    N = 20792.022
  fc = 33.00
   εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.0116768
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.0116768
      ωwe ((5.4c), TBDY) = ρse* αsh,min*fywe/fce+Min(ρfx, ρfy) = 0.04178759
    where ρf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

      ρfx = 0.02973616
    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
    αf = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788

      ρfy = 0.02973616
    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
    αf = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00444444
        bw = 450.00

effective stress from (A.35), ff,e = 773.4788

R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
fu,f = 840.00
Ef = 82000.00
u,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
    ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
    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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
    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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
    Lstir1 (Length of stirrups along Y) = 2160.00
    Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
    Lstir2 (Length of stirrups along Y) = 1568.00
    Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
    Lstir1 (Length of stirrups along X) = 2560.00
    Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
    Lstir2 (Length of stirrups along X) = 1968.00
    Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00227274
    c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04446081
2 = Asl,com/(b*d)*(fs2/fc) = 0.04446081
v = Asl,mid/(b*d)*(fsv/fc) = 0.1043468
and confined core properties:
b = 390.00
d = 877.00
d' = 13.00
fcc (5A.2, TBDY) = 33.90003
cc (5A.5, TBDY) = 0.00227274
c = confinement factor = 1.02727
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05305581
2 = Asl,com/(b*d)*(fs2/fc) = 0.05305581
v = Asl,mid/(b*d)*(fsv/fc) = 0.12451875
Case/Assumption: Unconfinesd full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.18345742
Mu = MRc (4.14) = 9.6932E+008
u =   su (4.1) = 6.9132751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
  u = 6.9132751E-006
Mu = 9.6932E+008
----
with full section properties:
  b = 450.00
  d = 907.00
  d' = 43.00
  v = 0.0015437
    N = 20792.022
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.0116768
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx,   fy) = 0.04178759
    where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----
      fx = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788
    ----
      fy = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788

      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
      fu,f = 840.00
      Ef = 82000.00
       u,f = 0.015
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
        ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
        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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
        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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
    Lstir1 (Length of stirrups along Y) = 2160.00
    Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
    Lstir2 (Length of stirrups along Y) = 1568.00
    Astir2 (stirrups area) = 50.26548

----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
    Lstir1 (Length of stirrups along X) = 2560.00
    Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
    Lstir2 (Length of stirrups along X) = 1968.00
    Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00227274
    c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.30
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04446081
2 = Asl,com/(b*d)*(fs2/fc) = 0.04446081
v = Asl,mid/(b*d)*(fsv/fc) = 0.1043468
and confined core properties:
b = 390.00
d = 877.00
d' = 13.00
fcc (5A.2, TBDY) = 33.90003
cc (5A.5, TBDY) = 0.00227274
c = confinement factor = 1.02727
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05305581
2 = Asl,com/(b*d)*(fs2/fc) = 0.05305581
v = Asl,mid/(b*d)*(fsv/fc) = 0.12451875
Case/Assumption: Unconfinesd full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.18345742
Mu = MRc (4.14) = 9.6932E+008
u =   su (4.1) = 6.9132751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.8004E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.8004E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 1.8004E+006
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 = 33.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.22911
Vu = 5.4210109E-020
d = 0.8*h = 760.00
Nu = 20792.022

Ag = 427500.00
From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 1.1114E+006
where:
Vs,jacket = Vs,j1 + Vs,j2 = 977392.20
Vs,j1 = 314161.779 is calculated for section web jacket, with:
   d = 360.00
   Av = 157079.633
   fy = 555.56
   s = 100.00
Vs,j1 is multiplied by   Col,j1 = 1.00
   s/d = 0.27777778
Vs,j2 = 663230.422 is calculated for section flange jacket, with:
   d = 760.00
   Av = 157079.633
   fy = 555.56
   s = 100.00
Vs,j2 is multiplied by   Col,j2 = 1.00
   s/d = 0.13157895
Vs,core = Vs,c1 + Vs,c2 = 134042.359
Vs,c1 = 0.00 is calculated for section web core, with:
   d = 200.00
   Av = 100530.965
   fy = 555.56
   s = 250.00
Vs,c1 is multiplied by   Col,c1 = 0.00
   s/d = 1.25
Vs,c2 = 134042.359 is calculated for section flange core, with:
   d = 600.00
   Av = 100530.965
   fy = 555.56
   s = 250.00
Vs,c2 is multiplied by   Col,c2 = 1.00
   s/d = 0.41666667
Vf ((11-3)-(11.4), ACI 440) = 594992.00
   f = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sin + cos is replaced with (cot +cota)sina which is more a generalised expression,
where   is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(,), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, =45° and =-45° to take into consideration the cyclic seismic loading.
orientation 1:   1 = b1 + 90° = 90.00
Vf = Min(|Vf(45, 1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.00
dfv = d (figure 11.2, ACI 440) = 907.00
ffe ((11-5), ACI 440) = 328.00
   Ef = 82000.00
    fe = 0.004, from (11.6a), ACI 440
      with fu = 0.009
From (11-11), ACI 440: Vs + Vf <= 1.3051E+006
   bw = 450.00

Calculation of Shear Strength at edge 2, Vr2 = 1.8004E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 1.8004E+006
  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 = 33.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
    Mu = 1.22911
    Vu = 5.4210109E-020
  d = 0.8*h = 760.00

Nu = 20792.022
Ag = 427500.00
From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 1.1114E+006
where:
Vs,jacket = Vs,j1 + Vs,j2 = 977392.20
Vs,j1 = 314161.779 is calculated for section web jacket, with:
  d = 360.00
  Av = 157079.633
  fy = 555.56
  s = 100.00
Vs,j1 is multiplied by   Col,j1 = 1.00
  s/d = 0.27777778
Vs,j2 = 663230.422 is calculated for section flange jacket, with:
  d = 760.00
  Av = 157079.633
  fy = 555.56
  s = 100.00
Vs,j2 is multiplied by   Col,j2 = 1.00
  s/d = 0.13157895
Vs,core = Vs,c1 + Vs,c2 = 134042.359
Vs,c1 = 0.00 is calculated for section web core, with:
  d = 200.00
  Av = 100530.965
  fy = 555.56
  s = 250.00
Vs,c1 is multiplied by   Col,c1 = 0.00
  s/d = 1.25
Vs,c2 = 134042.359 is calculated for section flange core, with:
  d = 600.00
  Av = 100530.965
  fy = 555.56
  s = 250.00
Vs,c2 is multiplied by   Col,c2 = 1.00
  s/d = 0.41666667
Vf ((11-3)-(11.4), ACI 440) = 594992.00
  f = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sin + cos is replaced with (cot +cota)sina which is more a generalised expression,
where   is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(,), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, =45° and =-45° to take into consideration the cyclic seismic loading.
orientation 1:   1 = b1 + 90° = 90.00
Vf = Min(|Vf(45, 1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.00
dfv = d (figure 11.2, ACI 440) = 907.00
ffe ((11-5), ACI 440) = 328.00
  Ef = 82000.00
  fe = 0.004, from (11.6a), ACI 440
    with fu = 0.009
From (11-11), ACI 440: Vs + Vf <= 1.3051E+006
  bw = 450.00

End Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column JTC1 of floor 1
At local axis: 2
Integration Section: (b)
Section Type: rcjtcs

Constant Properties

Knowledge Factor,   = 0.80

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 Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lb/ld = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

Stepwise Properties

Bending Moment, M = -71373.128
Shear Force, V2 = 5103.636
Shear Force, V3 = -67.97343
Axial Force, F = -21366.38
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1539.38
     -Compression: Asl,com = 2475.575
         -Middle: Asl,mid = 2676.637
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,jacket = 1231.504
     -Compression: Asl,com,jacket = 1859.823
         -Middle: Asl,mid,jacket = 2060.885
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,core = 307.8761
     -Compression: Asl,com,core = 615.7522
         -Middle: Asl,mid,core = 615.7522
Mean Diameter of Tension Reinforcement, DbL = 16.57143

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity   u,R = 1.0* u = 0.00093546

u = y + p = 0.00093546

- Calculation of y -
----
y = (My*Ls/3)/EIeff = 0.00093546 ((4.29),Biskinis Phd))
  My = 4.9044E+008
  Ls = M/V (with Ls > 0.1*L and Ls < 2*L) = 1050.015
  From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.8350E+014
    factor = 0.30
      Ag = 562500.00
      Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
      N = 21366.38
    Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 6.1166E+014

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 = 950.00
web width, bw = 450.00
flange thickness, t = 450.00
----
  y = Min(y_ten, y_com)
  y_ten = 2.7529339E-006
  with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 311.2112
    d = 707.00
     y = 0.20051568
    A = 0.01006514
    B = 0.0047321
     with pt = 0.00229194
        pc = 0.00368581
        pv = 0.00398517
        N = 21366.38
        b = 950.00
         " = 0.06082037
  y_comp = 1.5813624E-005
  with fc* (12.3, (ACI 440)) = 33.31981
    fc = 33.00
    fl = 0.5419822
    b = bmax = 950.00
    h = hmax = 750.00
    Ag = 0.5625
        g = pt + pc + pv = 0.00996292
    rc = 40.00
    Ae/Ac = 0.30198841
    Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
   effective strain from (12.5) and (12.12), efe = 0.004
    fu = 0.009
   Ef = 82000.00
   Ec = 26999.444
    y = 0.19868694
   A = 0.00989131
   B = 0.00462988
    with Es = 200000.00
CONFIRMATION: y = 0.19954485 < t/d

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

- Calculation of p -

From table 10-8: p = 0.00

with:
- Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
  shear control ratio V_{yE}/V_{Col0E} = 0.44505685
  d = d_external = 707.00
  s = s_external = 0.00
- t = s1 + s2 + 2*tf/bw*(ffe/fs) = 0.00620038
  jacket: s1 = Av1*Lstir1/(s1*Ag) = 0.00301593
      Av1 = 78.53982, is the area of every stirrup parallel to loading (shear) direction
      Lstir1 = 2160.00, is the total Length of all stirrups parallel to loading (shear) direction
      s1 = 100.00
  core: s2 = Av2*Lstir2/(s2*Ag) = 0.00056047
      Av2 = 50.26548, is the area of every stirrup parallel to loading (shear) direction
      Lstir2 = 1568.00, 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 = 21366.38
   Ag = 562500.00
   f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 33.00
   fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein = 555.56
   fytE = (fy_ext_Trans_Reinf* s1+fy_int_Trans_Reinf* s2)/(s1+ s2) = 555.56
pl = Area_Tot_Long_Rein/(b*d) = 0.00996292
  b = 950.00
  d = 707.00
   f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column JTC1 of floor 1
At local axis: 2
Integration Section: (b)

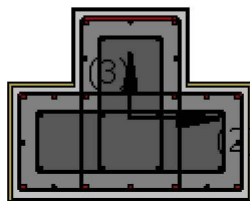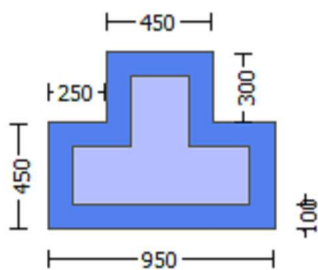

Calculation No. 7

column C1, Floor 1

Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (3)

Start Of Calculation of Shear Capacity for element: column JTC1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rcjtcs

Constant Properties

Knowledge Factor, = 0.80
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 Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
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 = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
##
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min =lb/ld = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00

Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -131936.98
Shear Force, Va = 67.97343
EDGE -B-
Bending Moment, Mb = -71373.128
Shear Force, Vb = -67.97343
BOTH EDGES
Axial Force, F = -21366.38
Longitudinal Reinforcement Area Distribution (in 2 divisions)
       -Tension: Aslt = 0.00
     -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
       -Tension: Asl,ten = 1539.38
     -Compression: Asl,com = 2475.575
         -Middle: Asl,mid = 2676.637
Mean Diameter of Tension Reinforcement, DbL,ten = 16.57143

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 1.2386E+006
Vn ((10.3), ASCE 41-17) = knl*VColO = 1.2386E+006
   VCol = 1.2386E+006
   knl = 1.00
       displacement_ductility_demand = 2.8092034E-007

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 = 2.00
     Mu = 71373.128
     Vu = 67.97343
   d = 0.8*h = 600.00
   Nu = 21366.38
   Ag = 337500.00
   From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 842449.486
   where:
   Vs,jacket = Vs,j1 + Vs,j2 = 753982.237
   Vs,j1 = 471238.898 is calculated for section web jacket, with:
     d = 600.00
     Av = 157079.633
     fy = 500.00
     s = 100.00
   Vs,j1 is multiplied by Col,j1 = 1.00
     s/d = 0.16666667
   Vs,j2 = 282743.339 is calculated for section flange jacket, with:
     d = 360.00
     Av = 157079.633
     fy = 500.00
     s = 100.00
   Vs,j2 is multiplied by Col,j2 = 1.00
     s/d = 0.27777778
   Vs,core = Vs,c1 + Vs,c2 = 88467.249
   Vs,c1 = 88467.249 is calculated for section web core, with:
     d = 440.00

Av = 100530.965
      fy = 500.00
      s = 250.00
   Vs,c1 is multiplied by   Col,c1 = 1.00
      s/d = 0.56818182
   Vs,c2 = 0.00 is calculated for section flange core, with:
      d = 200.00
      Av = 100530.965
      fy = 500.00
      s = 250.00
   Vs,c2 is multiplied by   Col,c2 = 0.00
      s/d = 1.25
   Vf ((11-3)-(11.4), ACI 440) = 463792.00
      f = 0.95, for fully-wrapped sections
   wf/sf = 1 (FRP strips adjacent to one another).
   In (11.3) sin + cos is replaced with (cot +cota)sina which is more a generalised expression,
   where   is the angle of the crack direction (see KANEPE).
   This later relation, considered as a function Vf(,), is implemented for every different fiber orientation ai,
   as well as for 2 crack directions, =45° and =-45° to take into consideration the cyclic seismic loading.
   orientation 1:   1 = b1 + 90° = 90.00
   Vf = Min(|Vf(45, 1)|,|Vf(-45,a1)|), with:
   total thickness per orientation, tf1 = NL*t/NoDir = 1.00
   dfv = d (figure 11.2, ACI 440) = 707.00
   ffe ((11-5), ACI 440) = 328.00
      Ef = 82000.00
       fe = 0.004, from (11.6a), ACI 440
         with fu = 0.009
   From (11-11), ACI 440: Vs + Vf <= 896810.169
      bw = 450.00

----
displacement_ductility_demand is calculated as   / y

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

From analysis, chord rotation   = 2.6279102E-010
  y = (My*Ls/3)/EIeff = 0.00093546 ((4.29),Biskinis Phd))
   My = 4.9044E+008
   Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1050.015
   From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.8350E+014
      factor = 0.30
         Ag = 562500.00
         Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
         N = 21366.38
      Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 6.1166E+014

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 = 950.00
web width, bw = 450.00
flange thickness, t = 450.00
----
  y = Min(y_ten, y_com)
  y_ten = 2.7529339E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 311.2112
      d = 707.00
       y = 0.20051568
     A = 0.01006514
     B = 0.0047321
      with pt = 0.00229194

```
        pc = 0.00368581
        pv = 0.00398517
         N = 21366.38
         b = 950.00
         " = 0.06082037
  y_comp = 1.5813624E-005
 with fc* (12.3, (ACI 440)) = 33.31981
     fc = 33.00
     fl = 0.5419822
     b = bmax = 950.00
     h = hmax = 750.00
     Ag = 0.5625
        g = pt + pc + pv = 0.00996292
       rc = 40.00
       Ae/Ac = 0.30198841
       Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
     effective strain from (12.5) and (12.12), efe = 0.004
      fu = 0.009
     Ef = 82000.00
    Ec = 26999.444
     y = 0.19868694
    A = 0.00989131
    B = 0.00462988
     with Es = 200000.00
CONFIRMATION:   y = 0.19954485 < t/d
------------------------------------------------------------
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
------------------------------------------------------------
End Of Calculation of Shear Capacity for element: column JTC1 of floor 1
At local axis: 3
Integration Section: (b)

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

Calculation No. 8
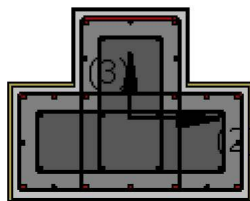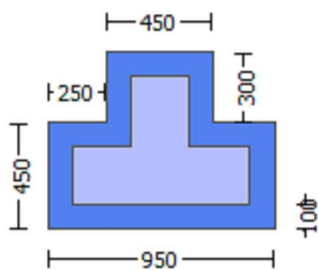
column C1, Floor 1

Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (u)

Edge: End

Local Axis: (3)

Start Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcjtcs

Constant Properties

Knowledge Factor,   = 0.80
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
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 = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
##
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.02727
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°

Number of layers, NL = 1
Radius of rounding corners, R = 40.00

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = -2.5087409E-020
EDGE -B-
Shear Force, Vb = 2.5087409E-020
BOTH EDGES
Axial Force, F = -20792.022
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
   -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 1539.38
    -Compression: Asl,com = 2475.575
       -Middle: Asl,mid = 2676.637

Calculation of Shear Capacity ratio , Ve/Vr = 0.44505685
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 632982.444
with
Mpr1 = Max(Mu1+ , Mu1-) = 9.4947E+008
   Mu1+ = 6.7087E+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- = 9.4947E+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-) = 9.4947E+008
   Mu2+ = 6.7087E+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- = 9.4947E+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 = 8.5351751E-006
Mu = 6.7087E+008
----
with full section properties:
  b = 950.00
  d = 707.00
  d' = 43.00
  v = 0.00093808
    N = 20792.022
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.0116768
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.04178759
    where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----
      fx = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00

hmax = 750.00
From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
   bw = 450.00
effective stress from (A.35), ff,e = 773.4788

----
fy = 0.02973616
Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
af = 0.28545185
with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
   bmax = 950.00
   hmax = 750.00
   From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
      bw = 450.00
   effective stress from (A.35), ff,e = 773.4788

R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
fu,f = 840.00
Ef = 82000.00
 u,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
   ase1 = Max((((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
   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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
   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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
   Lstir1 (Length of stirrups along Y) = 2160.00
   Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
   Lstir2 (Length of stirrups along Y) = 1568.00
   Astir2 (stirrups area) = 50.26548
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
   Lstir1 (Length of stirrups along X) = 2560.00
   Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
   Lstir2 (Length of stirrups along X) = 1968.00
   Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00

s2 = 250.00
  fywe1 = 694.45
  fywe2 = 694.45
  fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00227274
    c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
   su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esu1_nominal = 0.08,
  For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
  characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
   y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
   with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
   with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/lb,min = 0.30
   su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esu2_nominal = 0.08,
  For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
  characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
   y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
   with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
   with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
   suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esuv_nominal = 0.08,
  considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
  For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
  characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
   y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
   with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
   with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.02701806
  2 = Asl,com/(b*d)*(fs2/fc) = 0.04344945
  v = Asl,mid/(b*d)*(fsv/fc) = 0.04697834
and confined core properties:
 b = 890.00
 d = 677.00
 d' = 13.00
 fcc (5A.2, TBDY) = 33.90003
  cc (5A.5, TBDY) = 0.00227274
    c = confinement factor = 1.02727
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.03011747
  2 = Asl,com/(b*d)*(fs2/fc) = 0.04843381

```
      v = Asl,mid/(b*d)*(fsv/fc) = 0.05236752
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.15152684
Mu = MRc (4.14) = 6.7087E+008
  u =    su (4.1) = 8.5351751E-006
------------------------------------------------------------

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

-----------------------------------------------------------------------
Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
   u = 9.2428803E-006
Mu = 9.4947E+008
-----------------------------------------------------------------------
with full section properties:
   b = 450.00
   d = 707.00
   d' = 43.00
   v = 0.00198039
     N = 20792.022
   fc = 33.00
    co (5A.5, TBDY) = 0.002
   Final value of  cu:  cu* = shear_factor * Max( cu,  cc) = 0.0116768
       The Shear_factor is considered equal to 1 (pure moment strength)
       From (5.4b), TBDY:  cu = 0.0116768
          we ((5.4c), TBDY) = ase*  sh,min*fywe/fce+Min(  fx,   fy) = 0.04178759
       where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
       ------------------------------------------------------------------
          fx = 0.02973616
       Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
       af = 0.28545185
       with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
          bmax = 950.00
          hmax = 750.00
          From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
             bw = 450.00
          effective stress from (A.35), ff,e = 773.4788
       ------------------------------------------------------------------
          fy = 0.02973616
       Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
       af = 0.28545185
       with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
          bmax = 950.00
          hmax = 750.00
          From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
             bw = 450.00
          effective stress from (A.35), ff,e = 773.4788
       ------------------------------------------------------------------
          R = 40.00
          Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
          fu,f = 840.00
          Ef = 82000.00
           u,f = 0.015
          ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
             ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
             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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
  Lstir1 (Length of stirrups along Y) = 2160.00
  Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
  Lstir2 (Length of stirrups along Y) = 1568.00
  Astir2 (stirrups area) = 50.26548

----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
  Lstir1 (Length of stirrups along X) = 2560.00
  Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
  Lstir2 (Length of stirrups along X) = 1968.00
  Astir2 (stirrups area) = 50.26548

  Asec = 562500.00
  s1 = 100.00
  s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00227274
  c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
  su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
  with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
  with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044

sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/lb,min = 0.30
  su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esu2_nominal = 0.08,
  For calculation of esu2_nominal and ϵ_{y2}, sh2,ft2,fy2, it is considered
  characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
  ϵ_{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 = 389.0139
  with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
ϵ_{yv} = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
  suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esuv_nominal = 0.08,
  considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
  For calculation of esuv_nominal and ϵ_{yv}, shv,ftv,fyv, it is considered
  characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
  ϵ_{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 = 389.0139
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω_1 = Asl,ten/(b*d)*(fs1/fc) = 0.09172662
ω_2 = Asl,com/(b*d)*(fs2/fc) = 0.05703813
ω_v = Asl,mid/(b*d)*(fsv/fc) = 0.0991765
and confined core properties:
b = 390.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 33.90003
ϵ_{cc} (5A.5, TBDY) = 0.00227274
  c = confinement factor = 1.02727
ω_1 = Asl,ten/(b*d)*(fs1/fc) = 0.11052844
ω_2 = Asl,com/(b*d)*(fs2/fc) = 0.06872961
ω_v = Asl,mid/(b*d)*(fsv/fc) = 0.11950537
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
ω_v < $\omega_{s,y2}$ - LHS eq.(4.5) is satisfied
--->
ϵ_{su} (4.9) = 0.21649239
Mu = MRc (4.14) = 9.4947E+008
ϕ_u = ϕ_{su} (4.1) = 9.2428803E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
ϕ_u = 8.5351751E-006

Mu = 6.7087E+008

---

with full section properties:
  b = 950.00
  d = 707.00
  d' = 43.00
  v = 0.00093808
    N = 20792.022
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.0116768
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.04178759
    where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----
      fx = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788
    ----
      fy = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788

      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
      fu,f = 840.00
      Ef = 82000.00
      u,f = 0.015
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
        ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
        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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
        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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363

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 = 2.48363
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
   Lstir1 (Length of stirrups along Y) = 2160.00
   Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
   Lstir2 (Length of stirrups along Y) = 1568.00
   Astir2 (stirrups area) = 50.26548

----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
   Lstir1 (Length of stirrups along X) = 2560.00
   Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
   Lstir2 (Length of stirrups along X) = 1968.00
   Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00227274
  c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
  su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esu1_nominal = 0.08,
  For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
  characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
  with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
  with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/lb,min = 0.30
  su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esu2_nominal = 0.08,
  For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
  characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
  with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
  with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00

lo/lou,min = lb/ld = 0.30
  suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
 y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
 with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
 with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.02701806
 2 = Asl,com/(b*d)*(fs2/fc) = 0.04344945
 v = Asl,mid/(b*d)*(fsv/fc) = 0.04697834
and confined core properties:
  b = 890.00
  d = 677.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.90003
   cc (5A.5, TBDY) = 0.00227274
     c = confinement factor = 1.02727
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.03011747
   2 = Asl,com/(b*d)*(fs2/fc) = 0.04843381
   v = Asl,mid/(b*d)*(fsv/fc) = 0.05236752
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.15152684
Mu = MRc (4.14) = 6.7087E+008
  u =   su (4.1) = 8.5351751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 9.2428803E-006
Mu = 9.4947E+008
----
with full section properties:
  b = 450.00
  d = 707.00
  d' = 43.00
  v = 0.00198039
    N = 20792.022
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.0116768
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.04178759
    where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----
     fx = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+ (hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A4.4.3(6), pf = 2tf/bw = 0.00444444

bw = 450.00
effective stress from (A.35), ff,e = 773.4788
----
fy = 0.02973616
Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
af = 0.28545185
with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
bmax = 950.00
hmax = 750.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00444444
bw = 450.00
effective stress from (A.35), ff,e = 773.4788

R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
fu,f = 840.00
Ef = 82000.00
u,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45

```
        fywe2 = 694.45
        fce  = 33.00
     From ((5.A5), TBDY), TBDY:  cc = 0.00227274
         c  = confinement factor = 1.02727
   y1 = 0.00140044
   sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
   su1 = 0.00512
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/ld = 0.30
      su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esu1_nominal = 0.08,
     For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
     characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
      with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
      with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
   y2 = 0.00140044
   sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
   su2 = 0.00512
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/lb,min = 0.30
      su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esu2_nominal = 0.08,
     For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
     characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
      with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
      with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
   yv = 0.00140044
   shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
   suv = 0.00512
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/ld = 0.30
      suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esuv_nominal = 0.08,
     considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
     For calculation of esuv_nominal and  yv, shv,ftv,fyv, it is considered
     characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
      with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
      with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.09172662
   2 = Asl,com/(b*d)*(fs2/fc) = 0.05703813
   v = Asl,mid/(b*d)*(fsv/fc) = 0.0991765
and confined core properties:
   b = 390.00
   d = 677.00
   d' = 13.00
   fcc (5A.2, TBDY) = 33.90003
    cc (5A.5, TBDY) = 0.00227274
        c  = confinement factor = 1.02727
      1 = Asl,ten/(b*d)*(fs1/fc) = 0.11052844
      2 = Asl,com/(b*d)*(fs2/fc) = 0.06872961
      v = Asl,mid/(b*d)*(fsv/fc) = 0.11950537
Case/Assumption: Unconfinesd full section - Steel rupture
```

' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.21649239
Mu = MRc (4.14) = 9.4947E+008
  u =   su (4.1) = 9.2428803E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.4223E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.4223E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
   VCol0 = 1.4223E+006
   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 = 33.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
   M/Vd = 2.00
      Mu = 1533.833
      Vu = 2.5087409E-020
   d = 0.8*h = 600.00
   Nu = 20792.022
   Ag = 337500.00
   From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 936062.473
   where:
   Vs,jacket = Vs,j1 + Vs,j2 = 837764.743
   Vs,j1 = 523602.964 is calculated for section web jacket, with:
      d = 600.00
      Av = 157079.633
      fy = 555.56
      s = 100.00
   Vs,j1 is multiplied by   Col,j1 = 1.00
      s/d = 0.16666667
   Vs,j2 = 314161.779 is calculated for section flange jacket, with:
      d = 360.00
      Av = 157079.633
      fy = 555.56
      s = 100.00
   Vs,j2 is multiplied by   Col,j2 = 1.00
      s/d = 0.27777778
   Vs,core = Vs,c1 + Vs,c2 = 98297.73
   Vs,c1 = 98297.73 is calculated for section web core, with:
      d = 440.00
      Av = 100530.965
      fy = 555.56
      s = 250.00
   Vs,c1 is multiplied by   Col,c1 = 1.00
      s/d = 0.56818182
   Vs,c2 = 0.00 is calculated for section flange core, with:
      d = 200.00
      Av = 100530.965
      fy = 555.56
      s = 250.00
   Vs,c2 is multiplied by   Col,c2 = 0.00
      s/d = 1.25

Vf ((11-3)-(11.4), ACI 440) = 463792.00
     f = 0.95, for fully-wrapped sections
   wf/sf = 1 (FRP strips adjacent to one another).
   In (11.3) sin + cos is replaced with (cot +cota)sina which is more a generalised expression,
   where   is the angle of the crack direction (see KANEPE).
   This later relation, considered as a function Vf(,), is implemented for every different fiber orientation ai,
   as well as for 2 crack directions, =45° and =-45° to take into consideration the cyclic seismic loading.
   orientation 1: 1 = b1 + 90° = 90.00
   Vf = Min(|Vf(45, 1)|,|Vf(-45,a1)|), with:
   total thickness per orientation, tf1 = NL*t/NoDir = 1.00
   dfv = d (figure 11.2, ACI 440) = 707.00
   ffe ((11-5), ACI 440) = 328.00
      Ef = 82000.00
       fe = 0.004, from (11.6a), ACI 440
         with fu = 0.009
   From (11-11), ACI 440: Vs + Vf <= 1.0304E+006
      bw = 450.00

Calculation of Shear Strength at edge 2, Vr2 = 1.4223E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
   VCol0 = 1.4223E+006
   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 = 33.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
   M/Vd = 2.00
      Mu = 1533.833
      Vu = 2.5087409E-020
   d = 0.8*h = 600.00
   Nu = 20792.022
   Ag = 337500.00
   From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 936062.473
   where:
   Vs,jacket = Vs,j1 + Vs,j2 = 837764.743
   Vs,j1 = 523602.964 is calculated for section web jacket, with:
      d = 600.00
      Av = 157079.633
      fy = 555.56
      s = 100.00
   Vs,j1 is multiplied by Col,j1 = 1.00
      s/d = 0.16666667
   Vs,j2 = 314161.779 is calculated for section flange jacket, with:
      d = 360.00
      Av = 157079.633
      fy = 555.56
      s = 100.00
   Vs,j2 is multiplied by Col,j2 = 1.00
      s/d = 0.27777778
   Vs,core = Vs,c1 + Vs,c2 = 98297.73
   Vs,c1 = 98297.73 is calculated for section web core, with:
      d = 440.00
      Av = 100530.965
      fy = 555.56
      s = 250.00
   Vs,c1 is multiplied by Col,c1 = 1.00
      s/d = 0.56818182
   Vs,c2 = 0.00 is calculated for section flange core, with:
      d = 200.00
      Av = 100530.965
      fy = 555.56
      s = 250.00
   Vs,c2 is multiplied by Col,c2 = 0.00

s/d = 1.25
   Vf ((11-3)-(11.4), ACI 440) = 463792.00
      f = 0.95, for fully-wrapped sections
   wf/sf = 1 (FRP strips adjacent to one another).
  In (11.3) sin + cos is replaced with (cot +cota)sina which is more a generalised expression,
  where   is the angle of the crack direction (see KANEPE).
  This later relation, considered as a function Vf(,), is implemented for every different fiber orientation ai,
  as well as for 2 crack directions, = 45° and = -45° to take into consideration the cyclic seismic loading.
  orientation 1:   1 = b1 + 90° = 90.00
  Vf = Min(|Vf(45, 1)|,|Vf(-45,a1)|), with:
  total thickness per orientation, tf1 = NL*t/NoDir = 1.00
  dfv = d (figure 11.2, ACI 440) = 707.00
  ffe ((11-5), ACI 440) = 328.00
     Ef = 82000.00
      fe = 0.004, from (11.6a), ACI 440
       with fu = 0.009
   From (11-11), ACI 440: Vs + Vf <= 1.0304E+006
     bw = 450.00

End Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjtcs

Constant Properties

Knowledge Factor,   = 0.80
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
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 = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
##
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.02727
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = 5.4210109E-020
EDGE -B-
Shear Force, Vb = -5.4210109E-020
BOTH EDGES
Axial Force, F = -20792.022
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1539.38
     -Compression: Asl,com = 1539.38
         -Middle: Asl,mid = 3612.832

Calculation of Shear Capacity ratio , Ve/Vr = 0.3589236
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 646212.952
with
Mpr1 = Max(Mu1+ , Mu1-) = 9.6932E+008
   Mu1+ = 9.6932E+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- = 9.6932E+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-) = 9.6932E+008
   Mu2+ = 9.6932E+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- = 9.6932E+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 = 6.9132751E-006
Mu = 9.6932E+008
----
with full section properties:
   b = 450.00
   d = 907.00
   d' = 43.00
   v = 0.0015437
      N = 20792.022
   fc = 33.00
     co (5A.5, TBDY) = 0.002

Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768
   The Shear_factor is considered equal to 1 (pure moment strength)
   From (5.4b), TBDY: cu = 0.0116768
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+ Min(fx, fy) = 0.04178759
   where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----
   fx = 0.02973616
Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
af = 0.28545185
with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
   bmax = 950.00
   hmax = 750.00
   From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
      bw = 450.00
   effective stress from (A.35), ff,e = 773.4788
----
   fy = 0.02973616
Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
af = 0.28545185
with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
   bmax = 950.00
   hmax = 750.00
   From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
      bw = 450.00
   effective stress from (A.35), ff,e = 773.4788

   R = 40.00
   Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
   fu,f = 840.00
   Ef = 82000.00
    u,f = 0.015
   ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
      ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
      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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
      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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
   psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
      Lstir1 (Length of stirrups along Y) = 2160.00
      Astir1 (stirrups area) = 78.53982
   psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
      Lstir2 (Length of stirrups along Y) = 1568.00
      Astir2 (stirrups area) = 50.26548

```
        ------------------------------------------------------------------
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
            Lstir1 (Length of stirrups along X) = 2560.00
            Astir1 (stirrups area) = 78.53982
        psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
            Lstir2 (Length of stirrups along X) = 1968.00
            Astir2 (stirrups area) = 50.26548
        ------------------------------------------------------------------
            Asec = 562500.00
            s1 = 100.00
            s2 = 250.00
        fywe1 = 694.45
        fywe2 = 694.45
        fce  = 33.00
     From ((5.A5), TBDY), TBDY:  cc = 0.00227274
          c  = confinement factor = 1.02727
  y1 = 0.00140044
  sh1 = 0.0044814
 ft1 = 466.8167
 fy1 = 389.0139
  su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
      su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
      with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
      with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.00140044
  sh2 = 0.0044814
 ft2 = 466.8167
 fy2 = 389.0139
  su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.30
      su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
      with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
      with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00140044
  shv = 0.0044814
 ftv = 466.8167
 fyv = 389.0139
  suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
      suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and  yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
      with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
      with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.04446081
```

```
        2 = Asl,com/(b*d)*(fs2/fc) = 0.04446081
        v = Asl,mid/(b*d)*(fsv/fc) = 0.1043468
and confined core properties:
   b = 390.00
   d = 877.00
   d' = 13.00
   fcc (5A.2, TBDY) = 33.90003
     cc (5A.5, TBDY) = 0.00227274
       c = confinement factor = 1.02727
       1 = Asl,ten/(b*d)*(fs1/fc) = 0.05305581
       2 = Asl,com/(b*d)*(fs2/fc) = 0.05305581
       v = Asl,mid/(b*d)*(fsv/fc) = 0.12451875
Case/Assumption: Unconfinesd full section - Steel rupture
   ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
  su (4.9) = 0.18345742
Mu = MRc (4.14) = 9.6932E+008
  u =    su (4.1) = 6.9132751E-006
-----------------------------------------------------------

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

-------------------------------------------------------------------------
Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
   u = 6.9132751E-006
Mu = 9.6932E+008
-------------------------------------------------------------------------
with full section properties:
   b = 450.00
   d = 907.00
   d' = 43.00
   v = 0.0015437
     N = 20792.022
   fc = 33.00
     co (5A.5, TBDY) = 0.002
   Final value of   cu:  cu* = shear_factor * Max( cu, cc) = 0.0116768
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY:  cu = 0.0116768
       we ((5.4c), TBDY) = ase*  sh,min*fywe/fce+Min(  fx,   fy) = 0.04178759
     where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
     ------------------------------------------------------------------
       fx = 0.02973616
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
        bmax = 950.00
        hmax = 750.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
          bw = 450.00
        effective stress from (A.35), ff,e = 773.4788
     ------------------------------------------------------------------
       fy = 0.02973616
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
        bmax = 950.00
        hmax = 750.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
```

bw = 450.00
effective stress from (A.35), ff,e = 773.4788

R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
fu,f = 840.00
Ef = 82000.00
 u,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
    ase1 = Max((((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
    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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
    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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
    psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
        Lstir1 (Length of stirrups along Y) = 2160.00
        Astir1 (stirrups area) = 78.53982
    psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
        Lstir2 (Length of stirrups along Y) = 1568.00
        Astir2 (stirrups area) = 50.26548
----
    psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
    psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
        Lstir1 (Length of stirrups along X) = 2560.00
        Astir1 (stirrups area) = 78.53982
    psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
        Lstir2 (Length of stirrups along X) = 1968.00
        Astir2 (stirrups area) = 50.26548

    Asec = 562500.00
    s1 = 100.00
    s2 = 250.00
    fywe1 = 694.45
    fywe2 = 694.45
    fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00227274
    c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04446081
2 = Asl,com/(b*d)*(fs2/fc) = 0.04446081
v = Asl,mid/(b*d)*(fsv/fc) = 0.1043468
and confined core properties:
b = 390.00
d = 877.00
d' = 13.00
fcc (5A.2, TBDY) = 33.90003
cc (5A.5, TBDY) = 0.00227274
c = confinement factor = 1.02727
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05305581
2 = Asl,com/(b*d)*(fs2/fc) = 0.05305581
v = Asl,mid/(b*d)*(fsv/fc) = 0.12451875
Case/Assumption: Unconfinesd full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.18345742
Mu = MRc (4.14) = 9.6932E+008
u = su (4.1) = 6.9132751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
  u = 6.9132751E-006
Mu = 9.6932E+008
----
with full section properties:
  b = 450.00
  d = 907.00
  d' = 43.00
  v = 0.0015437
    N = 20792.022
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.0116768
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.04178759
    where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----
      fx = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788
    ----
      fy = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788

      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
      fu,f = 840.00
      Ef = 82000.00
       u,f = 0.015
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
        ase1 = Max((((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
        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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
        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.
$Aconf,max2 = 252164.00$ 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.
$Aconf,min2 = 111441.00$ 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.
$AnoConf2 = 110709.333$ is the unconfined internal core area which is equal to $bi2/6$ as defined at (A.2).
$psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.48363$
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)

$psh\_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.48363$
$psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593$
$Lstir1$ (Length of stirrups along Y) $= 2160.00$
$Astir1$ (stirrups area) $= 78.53982$
$psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047$
$Lstir2$ (Length of stirrups along Y) $= 1568.00$
$Astir2$ (stirrups area) $= 50.26548$

$psh\_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078$
$psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443$
$Lstir1$ (Length of stirrups along X) $= 2560.00$
$Astir1$ (stirrups area) $= 78.53982$
$psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345$
$Lstir2$ (Length of stirrups along X) $= 1968.00$
$Astir2$ (stirrups area) $= 50.26548$

$Asec = 562500.00$
$s1 = 100.00$
$s2 = 250.00$
$fywe1 = 694.45$
$fywe2 = 694.45$
$fce = 33.00$
From ((5.A5), TBDY), TBDY: $cc = 0.00227274$
c = confinement factor $= 1.02727$
$y1 = 0.00140044$
$sh1 = 0.0044814$
$ft1 = 466.8167$
$fy1 = 389.0139$
$su1 = 0.00512$
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
$lo/lou,min = lb/ld = 0.30$
$su1 = 0.4*esu1\_nominal ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esu1\_nominal = 0.08$,
For calculation of $esu1\_nominal$ and $y1$, $sh1,ft1,fy1$, it is considered
characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.
$y1$, $sh1,ft1,fy1$, are also multiplied by $Min(1,1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139$
with $Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00$
$y2 = 0.00140044$
$sh2 = 0.0044814$
$ft2 = 466.8167$
$fy2 = 389.0139$
$su2 = 0.00512$
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
$lo/lou,min = lb/lb,min = 0.30$
$su2 = 0.4*esu2\_nominal ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esu2\_nominal = 0.08$,
For calculation of $esu2\_nominal$ and $y2$, $sh2,ft2,fy2$, it is considered
characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
  with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
  with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
ε_{yv} = 0.00140044
ε_{shv} = 0.0044814
ftv = 466.8167
fyv = 389.0139
ε_{suv} = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
  ε_{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 ε_{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 = 389.0139
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω_1 = Asl,ten/(b*d)*(fs1/fc) = 0.04446081
ω_2 = Asl,com/(b*d)*(fs2/fc) = 0.04446081
ω_v = Asl,mid/(b*d)*(fsv/fc) = 0.1043468
and confined core properties:
  b = 390.00
  d = 877.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.90003
  ε_{cc} (5A.5, TBDY) = 0.00227274
    λ_c = confinement factor = 1.02727
  ω_1 = Asl,ten/(b*d)*(fs1/fc) = 0.05305581
  ω_2 = Asl,com/(b*d)*(fs2/fc) = 0.05305581
  ω_v = Asl,mid/(b*d)*(fsv/fc) = 0.12451875
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
ω_v < ωs,y2 - LHS eq.(4.5) is satisfied
--->
ε_{su} (4.9) = 0.18345742
Mu = MRc (4.14) = 9.6932E+008
 φ_u = φ_{su} (4.1) = 6.9132751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature φ_u according to 4.1, Biskinis/Fardis 2013:
 φ_u = 6.9132751E-006
Mu = 9.6932E+008
----
with full section properties:
  b = 450.00
  d = 907.00
  d' = 43.00
  ν = 0.0015437
   N = 20792.022
  fc = 33.00
  ε_{co} (5A.5, TBDY) = 0.002
  Final value of ε_{cu}: ε_{cu}* = shear_factor * Max(ε_{cu}, ε_{cc}) = 0.0116768
    The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: cu = 0.0116768
  we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.04178759
where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

----

  fx = 0.02973616
Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
af = 0.28545185
with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
  bmax = 950.00
  hmax = 750.00
  From EC8 A4.4.3(6), pf = 2tf/bw = 0.00444444
    bw = 450.00
  effective stress from (A.35), ff,e = 773.4788

----

  fy = 0.02973616
Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
af = 0.28545185
with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
  bmax = 950.00
  hmax = 750.00
  From EC8 A4.4.3(6), pf = 2tf/bw = 0.00444444
    bw = 450.00
  effective stress from (A.35), ff,e = 773.4788

  R = 40.00
  Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
  fu,f = 840.00
  Ef = 82000.00
  u,f = 0.015
  ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
    ase1 = Max((((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
    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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
    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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
 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 = 2.48363
  psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
    Lstir1 (Length of stirrups along Y) = 2160.00
    Astir1 (stirrups area) = 78.53982
  psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
    Lstir2 (Length of stirrups along Y) = 1568.00
    Astir2 (stirrups area) = 50.26548

----

  psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078

psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
   Lstir1 (Length of stirrups along X) = 2560.00
   Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
   Lstir2 (Length of stirrups along X) = 1968.00
   Astir2 (stirrups area) = 50.26548

   Asec = 562500.00
   s1 = 100.00
   s2 = 250.00
   fywe1 = 694.45
   fywe2 = 694.45
   fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00227274
   c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.30
   su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esu1_nominal = 0.08,
   For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
   characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
   y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
   with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
   with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/lb,min = 0.30
   su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esu2_nominal = 0.08,
   For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
   characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
   y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
   with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
   with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.30
   suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esuv_nominal = 0.08,
   considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
   For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
   characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
   y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
   with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
   with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04446081
2 = Asl,com/(b*d)*(fs2/fc) = 0.04446081
v = Asl,mid/(b*d)*(fsv/fc) = 0.1043468

and confined core properties:
   b = 390.00
   d = 877.00
   d' = 13.00
   fcc (5A.2, TBDY) = 33.90003
    cc (5A.5, TBDY) = 0.00227274
       c = confinement factor = 1.02727
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.05305581
     2 = Asl,com/(b*d)*(fs2/fc) = 0.05305581
     v = Asl,mid/(b*d)*(fsv/fc) = 0.12451875
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.18345742
Mu = MRc (4.14) = 9.6932E+008
 u =   su (4.1) = 6.9132751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.8004E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.8004E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
   VCol0 = 1.8004E+006
   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 = 33.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
   M/Vd = 2.00
      Mu = 1.22911
      Vu = 5.4210109E-020
   d = 0.8*h = 760.00
   Nu = 20792.022
   Ag = 427500.00
   From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 1.1114E+006
   where:
   Vs,jacket = Vs,j1 + Vs,j2 = 977392.20
    Vs,j1 = 314161.779 is calculated for section web jacket, with:
      d = 360.00
      Av = 157079.633
      fy = 555.56
      s = 100.00
    Vs,j1 is multiplied by   Col,j1 = 1.00
      s/d = 0.27777778
    Vs,j2 = 663230.422 is calculated for section flange jacket, with:
      d = 760.00
      Av = 157079.633
      fy = 555.56
      s = 100.00
    Vs,j2 is multiplied by   Col,j2 = 1.00
      s/d = 0.13157895
   Vs,core = Vs,c1 + Vs,c2 = 134042.359
    Vs,c1 = 0.00 is calculated for section web core, with:
      d = 200.00
      Av = 100530.965

fy = 555.56
s = 250.00
Vs,c1 is multiplied by Col,c1 = 0.00
s/d = 1.25
Vs,c2 = 134042.359 is calculated for section flange core, with:
d = 600.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs,c2 is multiplied by Col,c2 = 1.00
s/d = 0.41666667
Vf ((11-3)-(11.4), ACI 440) = 594992.00
f = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sin + cos is replaced with (cot +cota)sina which is more a generalised expression,
where is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(,), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, =45° and =-45° to take into consideration the cyclic seismic loading.
orientation 1: 1 = b1 + 90° = 90.00
Vf = Min(|Vf(45, 1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.00
dfv = d (figure 11.2, ACI 440) = 907.00
ffe ((11-5), ACI 440) = 328.00
Ef = 82000.00
fe = 0.004, from (11.6a), ACI 440
with fu = 0.009
From (11-11), ACI 440: Vs + Vf <= 1.3051E+006
bw = 450.00

Calculation of Shear Strength at edge 2, Vr2 = 1.8004E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 1.8004E+006
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 = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.22911
Vu = 5.4210109E-020
d = 0.8*h = 760.00
Nu = 20792.022
Ag = 427500.00
From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 1.1114E+006
where:
Vs,jacket = Vs,j1 + Vs,j2 = 977392.20
Vs,j1 = 314161.779 is calculated for section web jacket, with:
d = 360.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs,j1 is multiplied by Col,j1 = 1.00
s/d = 0.27777778
Vs,j2 = 663230.422 is calculated for section flange jacket, with:
d = 760.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs,j2 is multiplied by Col,j2 = 1.00
s/d = 0.13157895
Vs,core = Vs,c1 + Vs,c2 = 134042.359
Vs,c1 = 0.00 is calculated for section web core, with:
d = 200.00

Av = 100530.965
         fy = 555.56
         s = 250.00
      Vs,c1 is multiplied by   Col,c1 = 0.00
         s/d = 1.25
      Vs,c2 = 134042.359 is calculated for section flange core, with:
         d = 600.00
         Av = 100530.965
         fy = 555.56
         s = 250.00
      Vs,c2 is multiplied by   Col,c2 = 1.00
         s/d = 0.41666667
      Vf ((11-3)-(11.4), ACI 440) = 594992.00
         f = 0.95, for fully-wrapped sections
      wf/sf = 1 (FRP strips adjacent to one another).
      In (11.3) sin + cos is replaced with (cot +cota)sina which is more a generalised expression,
      where   is the angle of the crack direction (see KANEPE).
      This later relation, considered as a function Vf(,), is implemented for every different fiber orientation ai,
      as well as for 2 crack directions, =45° and =-45° to take into consideration the cyclic seismic loading.
      orientation 1:   1 = b1 + 90° = 90.00
      Vf = Min(|Vf(45, 1)|,|Vf(-45,a1)|), with:
      total thickness per orientation, tf1 = NL*t/NoDir = 1.00
      dfv = d (figure 11.2, ACI 440) = 907.00
      ffe ((11-5), ACI 440) = 328.00
         Ef = 82000.00
          fe = 0.004, from (11.6a), ACI 440
            with fu = 0.009
      From (11-11), ACI 440: Vs + Vf <= 1.3051E+006
         bw = 450.00

End Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column JTC1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rcjtcs

Constant Properties

Knowledge Factor,   = 0.80
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 Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member

Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lb/ld = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

Stepwise Properties

Bending Moment, M = 135025.377
Shear Force, V2 = 5103.636
Shear Force, V3 = -67.97343
Axial Force, F = -21366.38
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
   -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 1539.38
   -Compression: Asl,com = 1539.38
      -Middle: Asl,mid = 3612.832
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten,jacket = 1231.504
   -Compression: Asl,com,jacket = 1231.504
      -Middle: Asl,mid,jacket = 2689.203
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten,core = 307.8761
   -Compression: Asl,com,core = 307.8761
      -Middle: Asl,mid,core = 923.6282
Mean Diameter of Tension Reinforcement, DbL = 16.57143

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity   u,R = 1.0* u = 0.00024178
 u = y + p = 0.00024178

 - Calculation of y -
----
 y = (My*Ls/3)/EIeff = 0.00024178 ((4.29),Biskinis Phd))
  My = 6.7427E+008
  Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 300.00
  From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 2.7887E+014
     factor = 0.30
        Ag = 562500.00
        Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
        N = 21366.38
     Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 9.2958E+014

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7   -
----
 y = Min(y_ten, y_com)

y_ten = 2.3114142E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 311.2112
   d = 907.00
    y = 0.25776728
   A = 0.01656315
   B = 0.00875431
    with pt = 0.0037716
       pc = 0.0037716
       pv = 0.00885172
       N = 21366.38
       b = 450.00
        " = 0.04740904
  y_comp = 9.5688004E-006
 with fc* (12.3, (ACI 440)) = 33.31497
   fc = 33.00
   fl = 0.5419822
   b = bmax = 950.00
   h = hmax = 750.00
   Ag = 0.5625
      g = pt + pc + pv = 0.01639493
     rc = 40.00
     Ae/Ac = 0.29742395
     Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
   effective strain from (12.5) and (12.12), efe = 0.004
    fu = 0.009
   Ef = 82000.00
   Ec = 26999.444
    y = 0.25591301
   A = 0.01627709
   B = 0.0085861
    with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

 - Calculation of   p -

From table 10-8:   p = 0.00
with:
 - Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
   shear control ratio VyE/VCol0E = 0.3589236
  d = d_external = 907.00
  s = s_external = 0.00
 - t =   s1 +   s2 + 2*tf/bw*(ffe/fs) = 0.00690186
  jacket: s1 = Av1*Lstir1/(s1*Ag) = 0.00357443
       Av1 = 78.53982, is the area of every stirrup parallel to loading (shear) direction
       Lstir1 = 2560.00, is the total Length of all stirrups parallel to loading (shear) direction
       s1 = 100.00
  core: s2 = Av2*Lstir2/(s2*Ag) = 0.00070345
       Av2 = 50.26548, is the area of every stirrup parallel to loading (shear) direction
       Lstir2 = 1968.00, 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 = 21366.38
   Ag = 562500.00
   f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 33.00
   fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein =
555.56
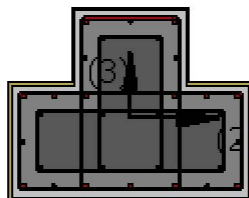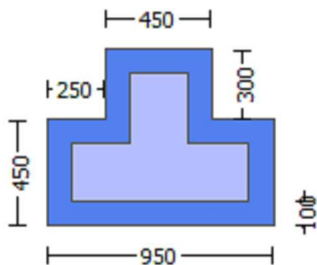   fytE = (fy_ext_Trans_Reinf* s1+fy_int_Trans_Reinf* s2)/(s1+ s2) = 555.56
pl = Area_Tot_Long_Rein/(b*d) = 0.01639493

b = 450.00
d = 907.00
  f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column JTC1 of floor 1
At local axis: 3
Integration Section: (b)

Calculation No. 9

column C1, Floor 1

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

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (2)

Start Of Calculation of Shear Capacity for element: column JTC1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rcjtcs

Constant Properties

Knowledge Factor,   = 0.80
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 Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column

New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
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 = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
###
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min =lb/ld = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -2.4188E+007
Shear Force, Va = -7990.756
EDGE -B-
Bending Moment, Mb = 211408.354
Shear Force, Vb = 7990.756
BOTH EDGES
Axial Force, F = -21691.294
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1539.38
     -Compression: Asl,com = 1539.38
         -Middle: Asl,mid = 3612.832
Mean Diameter of Tension Reinforcement, DbL,ten = 16.57143

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 1.3528E+006
Vn ((10.3), ASCE 41-17) = knl*VColO = 1.3528E+006
   VCol = 1.3528E+006

knl = 1.00
   displacement_ductility_demand = 0.02118308

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 = 3.98294
    Mu = 2.4188E+007
    Vu = 7990.756
  d = 0.8*h = 760.00
  Nu = 21691.294
  Ag = 427500.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 1.0003E+006
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 879645.943
  Vs,j1 = 282743.339 is calculated for section web jacket, with:
    d = 360.00
    Av = 157079.633
    fy = 500.00
    s = 100.00
  Vs,j1 is multiplied by Col,j1 = 1.00
    s/d = 0.27777778
  Vs,j2 = 596902.604 is calculated for section flange jacket, with:
    d = 760.00
    Av = 157079.633
    fy = 500.00
    s = 100.00
  Vs,j2 is multiplied by Col,j2 = 1.00
    s/d = 0.13157895
  Vs,core = Vs,c1 + Vs,c2 = 120637.158
  Vs,c1 = 0.00 is calculated for section web core, with:
    d = 200.00
    Av = 100530.965
    fy = 500.00
    s = 250.00
  Vs,c1 is multiplied by Col,c1 = 0.00
    s/d = 1.25
  Vs,c2 = 120637.158 is calculated for section flange core, with:
    d = 600.00
    Av = 100530.965
    fy = 500.00
    s = 250.00
  Vs,c2 is multiplied by Col,c2 = 1.00
    s/d = 0.41666667
  Vf ((11-3)-(11.4), ACI 440) = 594992.00
    f = 0.95, for fully-wrapped sections
  wf/sf = 1 (FRP strips adjacent to one another).
  In (11.3) sin + cos is replaced with (cot +cota)sina which is more a generalised expression,
  where is the angle of the crack direction (see KANEPE).
  This later relation, considered as a function Vf(,), is implemented for every different fiber orientation ai,
  as well as for 2 crack directions, =45° and =-45° to take into consideration the cyclic seismic loading.
  orientation 1: 1 = b1 + 90° = 90.00
  Vf = Min(|Vf(45, 1)|,|Vf(-45,a1)|), with:
  total thickness per orientation, tf1 = NL*t/NoDir = 1.00
  dfv = d (figure 11.2, ACI 440) = 907.00
  ffe ((11-5), ACI 440) = 328.00
    Ef = 82000.00
    fe = 0.004, from (11.6a), ACI 440
     with fu = 0.009
  From (11-11), ACI 440: Vs + Vf <= 1.1360E+006
    bw = 450.00

----

displacement_ductility_demand is calculated as μ / μy

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

From analysis, chord rotation θ = 5.1686829E-005
θy = (My*Ls/3)/EIeff = 0.00244 ((4.29),Biskinis Phd))
My = 6.7438E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3027.037
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 2.7887E+014
factor = 0.30
Ag = 562500.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 21691.294
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 9.2958E+014

Calculation of Yielding Moment My

Calculation of φy and My according to Annex 7 -

φy = Min(φy_ten, φy_com)
φy_ten = 2.3115293E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 311.2112
d = 907.00
ξy = 0.25780424
A = 0.0165657
B = 0.00875687
with pt = 0.0037716
pc = 0.0037716
pv = 0.00885172
N = 21691.294
b = 450.00
δ" = 0.04740904
φy_comp = 9.5684630E-006
with fc* (12.3, (ACI 440)) = 33.31497
fc = 33.00
fl = 0.5419822
b = bmax = 950.00
h = hmax = 750.00
Ag = 0.5625
ρg = pt + pc + pv = 0.01639493
rc = 40.00
Ae/Ac = 0.29742395
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
effective strain from (12.5) and (12.12), efe = 0.004
εfu = 0.009
Ef = 82000.00
Ec = 26999.444
ξy = 0.25592203
A = 0.01627529
B = 0.0085861
with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

End Of Calculation of Shear Capacity for element: column JTC1 of floor 1
At local axis: 2
Integration Section: (a)

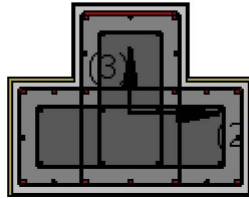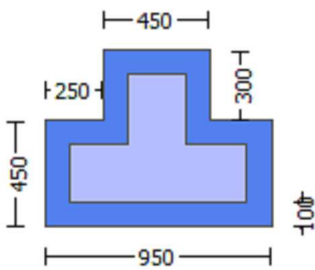
column C1, Floor 1

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

Analysis: Uniform +X

Check: Chord rotation capacity (u)

Edge: Start

Local Axis: (2)

Start Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcjtcs

Constant Properties

Knowledge Factor, = 0.80
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
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 = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
###
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00

Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.02727
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = -2.5087409E-020
EDGE -B-
Shear Force, Vb = 2.5087409E-020
BOTH EDGES
Axial Force, F = -20792.022
Longitudinal Reinforcement Area Distribution (in 2 divisions)
     -Tension: Aslt = 0.00
   -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
     -Tension: Asl,ten = 1539.38
   -Compression: Asl,com = 2475.575
     -Middle: Asl,mid = 2676.637

Calculation of Shear Capacity ratio , Ve/Vr = 0.44505685
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 632982.444
with
Mpr1 = Max(Mu1+ , Mu1-) = 9.4947E+008
  Mu1+ = 6.7087E+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- = 9.4947E+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-) = 9.4947E+008
  Mu2+ = 6.7087E+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- = 9.4947E+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:

$\varepsilon u = 8.5351751E-006$

$Mu = 6.7087E+008$

----

with full section properties:

  b = 950.00

  d = 707.00

  d' = 43.00

  v = 0.00093808

   N = 20792.022

  fc = 33.00

  εco (5A.5, TBDY) = 0.002

  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.0116768

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

    From (5.4b), TBDY: εcu = 0.0116768

      ωwe ((5.4c), TBDY) = αse*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.04178759

    where ωf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

      ωfx = 0.02973616

    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)

    αf = 0.28545185

    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667

      bmax = 950.00

      hmax = 750.00

      From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00444444

        bw = 450.00

      effective stress from (A.35), ff,e = 773.4788

      ωfy = 0.02973616

    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)

    αf = 0.28545185

    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667

      bmax = 950.00

      hmax = 750.00

      From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00444444

        bw = 450.00

      effective stress from (A.35), ff,e = 773.4788

    R = 40.00

    Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00

    fu,f = 840.00

    Ef = 82000.00

    εu,f = 0.015

    αse ((5.4d), TBDY) = (αse1*Aext+αse2*Aint)/Asec = 0.53375773

      αse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773

      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 = 464100.00 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 = 395025.00 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 = 173066.667 is the unconfined external core area which is equal to $\sum$bi2/6 as defined at (A.2).

    αse2 (>=αse1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773

      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 = 252164.00 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 = 111441.00 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 = 110709.333 is the unconfined internal core area which is equal to $\sum$bi2/6 as defined at (A.2).

psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.48363
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 = 2.48363
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
    Lstir1 (Length of stirrups along Y) = 2160.00
    Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
    Lstir2 (Length of stirrups along Y) = 1568.00
    Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
    Lstir1 (Length of stirrups along X) = 2560.00
    Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
    Lstir2 (Length of stirrups along X) = 1968.00
    Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00227274
    c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.30
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
 suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and   yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
 y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
 with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
 with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.02701806
2 = Asl,com/(b*d)*(fs2/fc) = 0.04344945
v = Asl,mid/(b*d)*(fsv/fc) = 0.04697834
and confined core properties:
 b = 890.00
 d = 677.00
 d' = 13.00
 fcc (5A.2, TBDY) = 33.90003
  cc (5A.5, TBDY) = 0.00227274
   c = confinement factor = 1.02727
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.03011747
   2 = Asl,com/(b*d)*(fs2/fc) = 0.04843381
   v = Asl,mid/(b*d)*(fsv/fc) = 0.05236752
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.15152684
Mu = MRc (4.14) = 6.7087E+008
 u =   su (4.1) = 8.5351751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
 u = 9.2428803E-006
Mu = 9.4947E+008
----
with full section properties:
 b = 450.00
 d = 707.00
 d' = 43.00
 v = 0.00198039
   N = 20792.022
 fc = 33.00
  co (5A.5, TBDY) = 0.002
 Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768
   The Shear_factor is considered equal to 1 (pure moment strength)
   From (5.4b), TBDY: cu = 0.0116768
     we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx,   fy) = 0.04178759
   where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
   ----
     fx = 0.02973616
   Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
   af = 0.28545185
   with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
     bmax = 950.00
     hmax = 750.00

151

From EC8 A4.4.3(6), pf = 2tf/bw = 0.00444444
   bw = 450.00
effective stress from (A.35), ff,e = 773.4788
----
  fy = 0.02973616
Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
af = 0.28545185
with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
   bmax = 950.00
   hmax = 750.00
   From EC8 A4.4.3(6), pf = 2tf/bw = 0.00444444
     bw = 450.00
   effective stress from (A.35), ff,e = 773.4788

   R = 40.00
   Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
   fu,f = 840.00
   Ef = 82000.00
   u,f = 0.015
   ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
     ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
     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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
     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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
   psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
     Lstir1 (Length of stirrups along Y) = 2160.00
     Astir1 (stirrups area) = 78.53982
   psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
     Lstir2 (Length of stirrups along Y) = 1568.00
     Astir2 (stirrups area) = 50.26548
----
   psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
   psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
     Lstir1 (Length of stirrups along X) = 2560.00
     Astir1 (stirrups area) = 78.53982
   psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
     Lstir2 (Length of stirrups along X) = 1968.00
     Astir2 (stirrups area) = 50.26548

   Asec = 562500.00
   s1 = 100.00
   s2 = 250.00

```
        fywe1 = 694.45
        fywe2 = 694.45
        fce  = 33.00
     From ((5.A5), TBDY), TBDY:  cc = 0.00227274
          c  = confinement factor = 1.02727
   y1 = 0.00140044
   sh1 = 0.0044814
  ft1 = 466.8167
  fy1 = 389.0139
   su1 = 0.00512
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/ld = 0.30
      su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esu1_nominal = 0.08,
     For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
     characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
      with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
      with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
   y2 = 0.00140044
   sh2 = 0.0044814
  ft2 = 466.8167
  fy2 = 389.0139
   su2 = 0.00512
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/lb,min = 0.30
      su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esu2_nominal = 0.08,
     For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
     characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
      with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
      with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
   yv = 0.00140044
   shv = 0.0044814
  ftv = 466.8167
  fyv = 389.0139
   suv = 0.00512
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/ld = 0.30
      suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esuv_nominal = 0.08,
     considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
     For calculation of esuv_nominal and  yv, shv,ftv,fyv, it is considered
     characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
      with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
      with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.09172662
     2 = Asl,com/(b*d)*(fs2/fc) = 0.05703813
     v = Asl,mid/(b*d)*(fsv/fc) = 0.0991765
 and confined core properties:
   b = 390.00
   d = 677.00
   d' = 13.00
  fcc (5A.2, TBDY) = 33.90003
   cc (5A.5, TBDY) = 0.00227274
      c  = confinement factor = 1.02727
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.11052844
     2 = Asl,com/(b*d)*(fs2/fc) = 0.06872961
     v = Asl,mid/(b*d)*(fsv/fc) = 0.11950537
```

Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.21649239
Mu = MRc (4.14) = 9.4947E+008
  u =   su (4.1) = 9.2428803E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 8.5351751E-006
Mu = 6.7087E+008
----
with full section properties:
  b = 950.00
  d = 707.00
  d' = 43.00
  v = 0.00093808
    N = 20792.022
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.0116768
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.04178759
    where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----
      fx = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A 4.4.3(6), pf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788
    ----
      fy = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A 4.4.3(6), pf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788

      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
      fu,f = 840.00
      Ef = 82000.00
       u,f = 0.015
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
        ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
        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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00227274
c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and   y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814

ft2 = 466.8167
fy2 = 389.0139
  su2 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/lb,min = 0.30
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esu2_nominal = 0.08,
   For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
   characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00140044
  shv = 0.0044814
 ftv = 466.8167
 fyv = 389.0139
  suv = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.30
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esuv_nominal = 0.08,
   considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
   For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
   characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.02701806
  2 = Asl,com/(b*d)*(fs2/fc) = 0.04344945
  v = Asl,mid/(b*d)*(fsv/fc) = 0.04697834
and confined core properties:
 b = 890.00
 d = 677.00
 d' = 13.00
 fcc (5A.2, TBDY) = 33.90003
  cc (5A.5, TBDY) = 0.00227274
   c = confinement factor = 1.02727
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.03011747
  2 = Asl,com/(b*d)*(fs2/fc) = 0.04843381
  v = Asl,mid/(b*d)*(fsv/fc) = 0.05236752
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.15152684
Mu = MRc (4.14) = 6.7087E+008
 u =   su (4.1) = 8.5351751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 u = 9.2428803E-006
Mu = 9.4947E+008

----

with full section properties:

  b = 450.00

  d = 707.00

  d' = 43.00

  ν = 0.00198039

    N = 20792.022

  fc = 33.00

  εco (5A.5, TBDY) = 0.002

  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.0116768

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

    From (5.4b), TBDY: εcu = 0.0116768

      ωwe ((5.4c), TBDY) = αse*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.04178759

    where ωf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

      ωfx = 0.02973616

    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)

    αf = 0.28545185

    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667

      bmax = 950.00

      hmax = 750.00

      From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00444444

        bw = 450.00

      effective stress from (A.35), ff,e = 773.4788

      ωfy = 0.02973616

    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)

    αf = 0.28545185

    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667

      bmax = 950.00

      hmax = 750.00

      From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00444444

        bw = 450.00

      effective stress from (A.35), ff,e = 773.4788

      R = 40.00

      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00

      fu,f = 840.00

      Ef = 82000.00

      εu,f = 0.015

      αse ((5.4d), TBDY) = (αse1*Aext+αse2*Aint)/Asec = 0.53375773

        αse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773

        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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773

        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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363

  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)

     $psh\_x*Fywe = psh1*Fywe1 + ps2*Fywe2 = 2.48363$

     $psh1\ ((5.4d),\ TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593$

       $Lstir1$ (Length of stirrups along Y) = 2160.00

       $Astir1$ (stirrups area) = 78.53982

     $psh2\ (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047$

       $Lstir2$ (Length of stirrups along Y) = 1568.00

       $Astir2$ (stirrups area) = 50.26548

     $psh\_y*Fywe = psh1*Fywe1 + ps2*Fywe2 = 2.97078$

     $psh1\ ((5.4d),\ TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443$

       $Lstir1$ (Length of stirrups along X) = 2560.00

       $Astir1$ (stirrups area) = 78.53982

     $psh2\ ((5.4d),\ TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345$

       $Lstir2$ (Length of stirrups along X) = 1968.00

       $Astir2$ (stirrups area) = 50.26548

       $Asec$ = 562500.00

       $s1$ = 100.00

       $s2$ = 250.00

       $fywe1$ = 694.45

       $fywe2$ = 694.45

       fce = 33.00

   From $((5.A5),\ TBDY),\ TBDY:\ cc = 0.00227274$

     c = confinement factor = 1.02727

 $y1$ = 0.00140044

 $sh1$ = 0.0044814

$ft1$ = 466.8167

$fy1$ = 389.0139

 $su1$ = 0.00512

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

  and also multiplied by the shear_factor according to 15.7.1.4, with

  Shear_factor = 1.00

  lo/lou,min = lb/ld = 0.30

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

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

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

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

  $y1,\ sh1,ft1,fy1$, are also multiplied by $Min(1, 1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

  with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139

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

 $y2$ = 0.00140044

 $sh2$ = 0.0044814

$ft2$ = 466.8167

$fy2$ = 389.0139

 $su2$ = 0.00512

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

  and also multiplied by the shear_factor according to 15.7.1.4, with

  Shear_factor = 1.00

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

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

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

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

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

  $y1,\ sh1,ft1,fy1$, are also multiplied by $Min(1, 1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

  with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139

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

 yv = 0.00140044

 shv = 0.0044814

ftv = 466.8167

fyv = 389.0139

 suv = 0.00512

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

  and also multiplied by the shear_factor according to 15.7.1.4, with

  Shear_factor = 1.00

  lo/lou,min = lb/ld = 0.30

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
 y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
 with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
 with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09172662
2 = Asl,com/(b*d)*(fs2/fc) = 0.05703813
v = Asl,mid/(b*d)*(fsv/fc) = 0.0991765
and confined core properties:
 b = 390.00
 d = 677.00
 d' = 13.00
 fcc (5A.2, TBDY) = 33.90003
 cc (5A.5, TBDY) = 0.00227274
    c = confinement factor = 1.02727
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.11052844
  2 = Asl,com/(b*d)*(fs2/fc) = 0.06872961
  v = Asl,mid/(b*d)*(fsv/fc) = 0.11950537
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.21649239
Mu = MRc (4.14) = 9.4947E+008
 u =   su (4.1) = 9.2428803E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.4223E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.4223E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 1.4223E+006
  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 = 33.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
 M/Vd = 2.00
   Mu = 1533.833
   Vu = 2.5087409E-020
 d = 0.8*h = 600.00
 Nu = 20792.022
 Ag = 337500.00
 From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 936062.473
 where:
 Vs,jacket = Vs,j1 + Vs,j2 = 837764.743
 Vs,j1 = 523602.964 is calculated for section web jacket, with:
  d = 600.00
  Av = 157079.633
  fy = 555.56
  s = 100.00
 Vs,j1 is multiplied by Col,j1 = 1.00
  s/d = 0.16666667

Vs,j2 = 314161.779 is calculated for section flange jacket, with:
   d = 360.00
   Av = 157079.633
   fy = 555.56
   s = 100.00
Vs,j2 is multiplied by   Col,j2 = 1.00
   s/d = 0.27777778
Vs,core = Vs,c1 + Vs,c2 = 98297.73
Vs,c1 = 98297.73 is calculated for section web core, with:
   d = 440.00
   Av = 100530.965
   fy = 555.56
   s = 250.00
Vs,c1 is multiplied by   Col,c1 = 1.00
   s/d = 0.56818182
Vs,c2 = 0.00 is calculated for section flange core, with:
   d = 200.00
   Av = 100530.965
   fy = 555.56
   s = 250.00
Vs,c2 is multiplied by   Col,c2 = 0.00
   s/d = 1.25
Vf ((11-3)-(11.4), ACI 440) = 463792.00
   ϕ_f = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sin + cos is replaced with (cot +cota)sina which is more a generalised expression,
where   is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(,), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, =45° and =-45° to take into consideration the cyclic seismic loading.
orientation 1:   1 = b1 + 90° = 90.00
Vf = Min(|Vf(45, 1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.00
dfv = d (figure 11.2, ACI 440) = 707.00
ffe ((11-5), ACI 440) = 328.00
   Ef = 82000.00
    ϵ_{fe} = 0.004, from (11.6a), ACI 440
      with ϵ_{fu} = 0.009
From (11-11), ACI 440: Vs + Vf <= 1.0304E+006
   bw = 450.00

Calculation of Shear Strength at edge 2, Vr2 = 1.4223E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
   VCol0 = 1.4223E+006
   knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ ϕ_f*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 = 33.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
   M/Vd = 2.00
      Mu = 1533.833
      Vu = 2.5087409E-020
   d = 0.8*h = 600.00
   Nu = 20792.022
   Ag = 337500.00
   From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 936062.473
   where:
Vs,jacket = Vs,j1 + Vs,j2 = 837764.743
Vs,j1 = 523602.964 is calculated for section web jacket, with:
   d = 600.00
   Av = 157079.633
   fy = 555.56
   s = 100.00
Vs,j1 is multiplied by   Col,j1 = 1.00

s/d = 0.16666667
Vs,j2 = 314161.779 is calculated for section flange jacket, with:
  d = 360.00
  Av = 157079.633
  fy = 555.56
  s = 100.00
Vs,j2 is multiplied by   Col,j2 = 1.00
  s/d = 0.27777778
Vs,core = Vs,c1 + Vs,c2 = 98297.73
Vs,c1 = 98297.73 is calculated for section web core, with:
  d = 440.00
  Av = 100530.965
  fy = 555.56
  s = 250.00
Vs,c1 is multiplied by   Col,c1 = 1.00
  s/d = 0.56818182
Vs,c2 = 0.00 is calculated for section flange core, with:
  d = 200.00
  Av = 100530.965
  fy = 555.56
  s = 250.00
Vs,c2 is multiplied by   Col,c2 = 0.00
  s/d = 1.25
Vf ((11-3)-(11.4), ACI 440) = 463792.00
  f = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sin + cos is replaced with (cot +cota)sina which is more a generalised expression,
where   is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(,), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, =45° and =-45° to take into consideration the cyclic seismic loading.
orientation 1:   1 = b1 + 90° = 90.00
Vf = Min(|Vf(45, 1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.00
dfv = d (figure 11.2, ACI 440) = 707.00
ffe ((11-5), ACI 440) = 328.00
  Ef = 82000.00
   fe = 0.004, from (11.6a), ACI 440
    with   fu = 0.009
From (11-11), ACI 440: Vs + Vf <= 1.0304E+006
  bw = 450.00

End Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjtcs

Constant Properties

Knowledge Factor,   = 0.80
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444

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 = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
##
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.02727
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = 5.4210109E-020
EDGE -B-
Shear Force, Vb = -5.4210109E-020
BOTH EDGES
Axial Force, F = -20792.022
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1539.38
     -Compression: Asl,com = 1539.38
        -Middle: Asl,mid = 3612.832

Calculation of Shear Capacity ratio , Ve/Vr = 0.3589236
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 646212.952
with
Mpr1 = Max(Mu1+ , Mu1-) = 9.6932E+008
   Mu1+ = 9.6932E+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- = 9.6932E+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-) = 9.6932E+008

Mu2+ = 9.6932E+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- = 9.6932E+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 = 6.9132751E-006
Mu = 9.6932E+008
----
with full section properties:
  b = 450.00
  d = 907.00
  d' = 43.00
  v = 0.0015437
    N = 20792.022
  fc = 33.00
  εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.0116768
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.0116768
      ωwe ((5.4c), TBDY) = ρse*ρsh,min*fywe/fce+Min(ρfx, ρfy) = 0.04178759
    where ρf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

      ρfx = 0.02973616
    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
    αf = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788

      ρfy = 0.02973616
    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
    αf = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788

      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
      fu,f = 840.00
      Ef = 82000.00
      εu,f = 0.015
      ρse ((5.4d), TBDY) = (ρse1*Aext+ρse2*Aint)/Asec = 0.53375773
        ρse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
        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 = 464100.00 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 = 395025.00 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 = 173066.667 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
      ρse2 (>=ρse1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773

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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
   Lstir1 (Length of stirrups along Y) = 2160.00
   Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
   Lstir2 (Length of stirrups along Y) = 1568.00
   Astir2 (stirrups area) = 50.26548

----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
   Lstir1 (Length of stirrups along X) = 2560.00
   Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
   Lstir2 (Length of stirrups along X) = 1968.00
   Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00227274
  c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered

characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
  with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
  with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
 yv = 0.00140044
 shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
 suv = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
   suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esuv_nominal = 0.08,
  considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
  For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
  characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
   y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
   with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
   with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.04446081
  2 = Asl,com/(b*d)*(fs2/fc) = 0.04446081
  v = Asl,mid/(b*d)*(fsv/fc) = 0.1043468
and confined core properties:
 b = 390.00
 d = 877.00
 d' = 13.00
 fcc (5A.2, TBDY) = 33.90003
  cc (5A.5, TBDY) = 0.00227274
    c = confinement factor = 1.02727
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.05305581
   2 = Asl,com/(b*d)*(fs2/fc) = 0.05305581
   v = Asl,mid/(b*d)*(fsv/fc) = 0.12451875
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.18345742
Mu = MRc (4.14) = 9.6932E+008
  u =   su (4.1) = 6.9132751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 6.9132751E-006
Mu = 9.6932E+008
----
with full section properties:
 b = 450.00
 d = 907.00
 d' = 43.00
 v = 0.0015437
   N = 20792.022
 fc = 33.00
  co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768

The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0116768
  we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.04178759
where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----
  fx = 0.02973616
Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
af = 0.28545185
with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
  bmax = 950.00
  hmax = 750.00
  From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
    bw = 450.00
  effective stress from (A.35), ff,e = 773.4788
----
  fy = 0.02973616
Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
af = 0.28545185
with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
  bmax = 950.00
  hmax = 750.00
  From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
    bw = 450.00
  effective stress from (A.35), ff,e = 773.4788

  R = 40.00
  Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
  fu,f = 840.00
  Ef = 82000.00
   u,f = 0.015
  ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
    ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
    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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
    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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
  psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
    Lstir1 (Length of stirrups along Y) = 2160.00
    Astir1 (stirrups area) = 78.53982
  psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
    Lstir2 (Length of stirrups along Y) = 1568.00
    Astir2 (stirrups area) = 50.26548

```
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
           Lstir1 (Length of stirrups along X) = 2560.00
           Astir1 (stirrups area) = 78.53982
        psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
           Lstir2 (Length of stirrups along X) = 1968.00
           Astir2 (stirrups area) = 50.26548
     --------------------------------------------------------------------
           Asec = 562500.00
           s1 = 100.00
           s2 = 250.00
         fywe1 = 694.45
         fywe2 = 694.45
         fce  = 33.00
     From ((5.A5), TBDY), TBDY:  cc = 0.00227274
         c = confinement factor = 1.02727
   y1 = 0.00140044
   sh1 = 0.0044814
 ft1 = 466.8167
 fy1 = 389.0139
   su1 = 0.00512
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/ld = 0.30
      su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esu1_nominal = 0.08,
     For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
     characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
      with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
      with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
   y2 = 0.00140044
   sh2 = 0.0044814
 ft2 = 466.8167
 fy2 = 389.0139
   su2 = 0.00512
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/lb,min = 0.30
      su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esu2_nominal = 0.08,
     For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
     characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
      with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
      with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
   yv = 0.00140044
   shv = 0.0044814
 ftv = 466.8167
 fyv = 389.0139
   suv = 0.00512
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/ld = 0.30
      suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esuv_nominal = 0.08,
     considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
     For calculation of esuv_nominal and  yv, shv,ftv,fyv, it is considered
     characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
      with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
      with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.04446081
   2 = Asl,com/(b*d)*(fs2/fc) = 0.04446081
```

v = Asl,mid/(b*d)*(fsv/fc) = 0.1043468
and confined core properties:
  b = 390.00
  d = 877.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.90003
    cc (5A.5, TBDY) = 0.00227274
      c = confinement factor = 1.02727
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.05305581
    2 = Asl,com/(b*d)*(fs2/fc) = 0.05305581
      v = Asl,mid/(b*d)*(fsv/fc) = 0.12451875
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.18345742
Mu = MRc (4.14) = 9.6932E+008
  u =   su (4.1) = 6.9132751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 6.9132751E-006
Mu = 9.6932E+008
----
with full section properties:
  b = 450.00
  d = 907.00
  d' = 43.00
  v = 0.0015437
    N = 20792.022
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.0116768
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx,   fy) = 0.04178759
    where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----
      fx = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
        bmax = 950.00
        hmax = 750.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
          bw = 450.00
        effective stress from (A.35), ff,e = 773.4788
    ----
      fy = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
        bmax = 950.00
        hmax = 750.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
          bw = 450.00

effective stress from (A.35), ff,e = 773.4788

R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
fu,f = 840.00
Ef = 82000.00
u,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
   ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
   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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
   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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
   Lstir1 (Length of stirrups along Y) = 2160.00
   Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
   Lstir2 (Length of stirrups along Y) = 1568.00
   Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
   Lstir1 (Length of stirrups along X) = 2560.00
   Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
   Lstir2 (Length of stirrups along X) = 1968.00
   Astir2 (stirrups area) = 50.26548

   Asec = 562500.00
   s1 = 100.00
   s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00227274
   c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
   su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esu1_nominal = 0.08,
  For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
  characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
   y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
   with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
   with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
 y2 = 0.00140044
 sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
 su2 = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/lb,min = 0.30
   su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esu2_nominal = 0.08,
  For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
  characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
   y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
   with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
   with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
 yv = 0.00140044
 shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
 suv = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
   suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esuv_nominal = 0.08,
  considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
  For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
  characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
   y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
   with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
   with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.04446081
 2 = Asl,com/(b*d)*(fs2/fc) = 0.04446081
 v = Asl,mid/(b*d)*(fsv/fc) = 0.1043468
and confined core properties:
 b = 390.00
 d = 877.00
 d' = 13.00
 fcc (5A.2, TBDY) = 33.90003
  cc (5A.5, TBDY) = 0.00227274
   c = confinement factor = 1.02727
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.05305581
  2 = Asl,com/(b*d)*(fs2/fc) = 0.05305581
  v = Asl,mid/(b*d)*(fsv/fc) = 0.12451875
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.18345742
Mu = MRc (4.14) = 9.6932E+008
 u =   su (4.1) = 6.9132751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 6.9132751E-006
Mu = 9.6932E+008
----
with full section properties:
  b = 450.00
  d = 907.00
  d' = 43.00
  v = 0.0015437
    N = 20792.022
  fc = 33.00
   εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu^* = shear_factor * Max(εcu, εcc) = 0.0116768
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.0116768
      ωwe ((5.4c), TBDY) = $\alpha se^*\rho sh,min*fywe/fce+Min(\alpha fx, \alpha fy)$ = 0.04178759
    where ωf = $\alpha f*\rho f*ffe/fce$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

      αfx = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788

      αfy = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788

      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
      fu,f = 840.00
      Ef = 82000.00
       $\varepsilon u,f$ = 0.015
      αse ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
        ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
        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 = 464100.00 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 = 395025.00 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 = 173066.667 is the unconfined external core area which is equal to $\sum bi2/6$ as defined at (A.2).
      ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
        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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
   Lstir1 (Length of stirrups along Y) = 2160.00
   Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
   Lstir2 (Length of stirrups along Y) = 1568.00
   Astir2 (stirrups area) = 50.26548

----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
   Lstir1 (Length of stirrups along X) = 2560.00
   Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
   Lstir2 (Length of stirrups along X) = 1968.00
   Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00227274
   c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
  su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esu1_nominal = 0.08,
  For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
  characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
  with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
  with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/lb,min = 0.30
  su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esu2_nominal = 0.08,
  For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
  characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04446081
2 = Asl,com/(b*d)*(fs2/fc) = 0.04446081
v = Asl,mid/(b*d)*(fsv/fc) = 0.1043468
and confined core properties:
b = 390.00
d = 877.00
d' = 13.00
fcc (5A.2, TBDY) = 33.90003
cc (5A.5, TBDY) = 0.00227274
c = confinement factor = 1.02727
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05305581
2 = Asl,com/(b*d)*(fs2/fc) = 0.05305581
v = Asl,mid/(b*d)*(fsv/fc) = 0.12451875
Case/Assumption: Unconfinesd full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.18345742
Mu = MRc (4.14) = 9.6932E+008
u =   su (4.1) = 6.9132751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.8004E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.8004E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 1.8004E+006
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 = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.22911
Vu = 5.4210109E-020
d = 0.8*h = 760.00
Nu = 20792.022

Ag = 427500.00
From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 1.1114E+006
where:
Vs,jacket = Vs,j1 + Vs,j2 = 977392.20
Vs,j1 = 314161.779 is calculated for section web jacket, with:
  d = 360.00
  Av = 157079.633
  fy = 555.56
  s = 100.00
Vs,j1 is multiplied by Col,j1 = 1.00
  s/d = 0.27777778
Vs,j2 = 663230.422 is calculated for section flange jacket, with:
  d = 760.00
  Av = 157079.633
  fy = 555.56
  s = 100.00
Vs,j2 is multiplied by Col,j2 = 1.00
  s/d = 0.13157895
Vs,core = Vs,c1 + Vs,c2 = 134042.359
Vs,c1 = 0.00 is calculated for section web core, with:
  d = 200.00
  Av = 100530.965
  fy = 555.56
  s = 250.00
Vs,c1 is multiplied by Col,c1 = 0.00
  s/d = 1.25
Vs,c2 = 134042.359 is calculated for section flange core, with:
  d = 600.00
  Av = 100530.965
  fy = 555.56
  s = 250.00
Vs,c2 is multiplied by Col,c2 = 1.00
  s/d = 0.41666667
Vf ((11-3)-(11.4), ACI 440) = 594992.00
  ψ_f = 0.95, for fully-wrapped sections
  wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sin α + cos α is replaced with (cot θ +cotα)sinα which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ, α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ =45° and θ =-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45, α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.00
dfv = d (figure 11.2, ACI 440) = 907.00
ffe ((11-5), ACI 440) = 328.00
  Ef = 82000.00
  εfe = 0.004, from (11.6a), ACI 440
    with εfu = 0.009
From (11-11), ACI 440: Vs + Vf <= 1.3051E+006
  bw = 450.00

Calculation of Shear Strength at edge 2, Vr2 = 1.8004E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 1.8004E+006
  knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ ψ_f*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 = 33.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
  Mu = 1.22911
  Vu = 5.4210109E-020
d = 0.8*h = 760.00

174

Nu = 20792.022
Ag = 427500.00
From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 1.1114E+006
where:
Vs,jacket = Vs,j1 + Vs,j2 = 977392.20
Vs,j1 = 314161.779 is calculated for section web jacket, with:
   d = 360.00
   Av = 157079.633
   fy = 555.56
   s = 100.00
Vs,j1 is multiplied by   Col,j1 = 1.00
   s/d = 0.27777778
Vs,j2 = 663230.422 is calculated for section flange jacket, with:
   d = 760.00
   Av = 157079.633
   fy = 555.56
   s = 100.00
Vs,j2 is multiplied by   Col,j2 = 1.00
   s/d = 0.13157895
Vs,core = Vs,c1 + Vs,c2 = 134042.359
Vs,c1 = 0.00 is calculated for section web core, with:
   d = 200.00
   Av = 100530.965
   fy = 555.56
   s = 250.00
Vs,c1 is multiplied by   Col,c1 = 0.00
   s/d = 1.25
Vs,c2 = 134042.359 is calculated for section flange core, with:
   d = 600.00
   Av = 100530.965
   fy = 555.56
   s = 250.00
Vs,c2 is multiplied by   Col,c2 = 1.00
   s/d = 0.41666667
Vf ((11-3)-(11.4), ACI 440) = 594992.00
   f = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sin + cos is replaced with (cot +cota)sina which is more a generalised expression,
where   is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(,), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, =45° and =-45° to take into consideration the cyclic seismic loading.
orientation 1:   1 = b1 + 90° = 90.00
Vf = Min(|Vf(45, 1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.00
dfv = d (figure 11.2, ACI 440) = 907.00
ffe ((11-5), ACI 440) = 328.00
   Ef = 82000.00
    fe = 0.004, from (11.6a), ACI 440
      with fu = 0.009
From (11-11), ACI 440: Vs + Vf <= 1.3051E+006
   bw = 450.00

End Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column JTC1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rcjtcs

Constant Properties

Knowledge Factor,   = 0.80

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 Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lb/ld = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

Stepwise Properties

Bending Moment, M = -207441.237
Shear Force, V2 = -7990.756
Shear Force, V3 = 106.4259
Axial Force, F = -21691.294
Longitudinal Reinforcement Area Distribution (in 2 divisions)
       -Tension: Aslt = 0.00
    -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
       -Tension: Asl,ten = 1539.38
     -Compression: Asl,com = 2475.575
        -Middle: Asl,mid = 2676.637
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
       -Tension: Asl,ten,jacket = 1231.504
     -Compression: Asl,com,jacket = 1859.823
        -Middle: Asl,mid,jacket = 2060.885
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
       -Tension: Asl,ten,core = 307.8761
     -Compression: Asl,com,core = 615.7522
        -Middle: Asl,mid,core = 615.7522
Mean Diameter of Tension Reinforcement, DbL = 16.57143

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity   u,R = 1.0* u = 0.03173686

u = y + p = 0.03173686

 - Calculation of y -
----
 y = (My*Ls/3)/EIeff = 0.00173686 ((4.29),Biskinis Phd))
  My = 4.9054E+008
  Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1949.161
  From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.8350E+014
     factor = 0.30
        Ag = 562500.00
        Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
        N = 21691.294
     Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 6.1166E+014

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 = 950.00
web width, bw = 450.00
flange thickness, t = 450.00
----
  y = Min(y_ten, y_com)
  y_ten = 2.7530492E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 311.2112
    d = 707.00
     y = 0.20054914
    A = 0.01006669
    B = 0.00473366
     with pt = 0.00229194
        pc = 0.00368581
        pv = 0.00398517
        N = 21691.294
        b = 950.00
        " = 0.06082037
  y_comp = 1.5813155E-005
 with fc* (12.3, (ACI 440)) = 33.31981
    fc = 33.00
    fl = 0.5419822
    b = bmax = 950.00
    h = hmax = 750.00
    Ag = 0.5625
        g = pt + pc + pv = 0.00996292
    rc = 40.00
    Ae/Ac = 0.30198841
    Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
   effective strain from (12.5) and (12.12), efe = 0.004
    fu = 0.009
   Ef = 82000.00
   Ec = 26999.444
    y = 0.19869284
    A = 0.00989022
    B = 0.00462988
     with Es = 200000.00
CONFIRMATION: y = 0.19956371 < t/d

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

- Calculation of p -

From table 10-8:   p = 0.03

with:

- Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1

  shear control ratio VyE/VCol0E = 0.44505685

  d = d_external = 707.00

  s = s_external = 0.00

- t =   s1 +   s2 + 2*tf/bw*(ffe/fs) = 0.00620038

  jacket: s1 = Av1*Lstir1/(s1*Ag) = 0.00301593

       Av1 = 78.53982, is the area of every stirrup parallel to loading (shear) direction

       Lstir1 = 2160.00, is the total Length of all stirrups parallel to loading (shear) direction

       s1 = 100.00

  core: s2 = Av2*Lstir2/(s2*Ag) = 0.00056047

       Av2 = 50.26548, is the area of every stirrup parallel to loading (shear) direction

       Lstir2 = 1568.00, 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 = 21691.294

   Ag = 562500.00

   f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 33.00

   fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein = 555.56

   fytE = (fy_ext_Trans_Reinf* s1+fy_int_Trans_Reinf* s2)/(s1+ s2) = 555.56

pl = Area_Tot_Long_Rein/(b*d) = 0.00996292

   b = 950.00

   d = 707.00

    f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column JTC1 of floor 1

At local axis: 2

Integration Section: (a)

Calculation No. 11

column C1, Floor 1
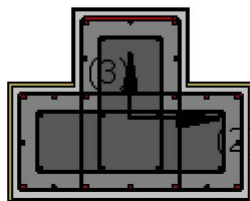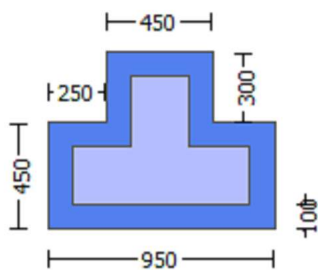
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (3)

Start Of Calculation of Shear Capacity for element: column JTC1 of floor 1
At local axis: 3
Integration Section: (a)
Section Type: rcjtcs

Constant Properties

Knowledge Factor,   = 0.80
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 Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
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 = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
##
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min =lb/ld = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00

Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -207441.237
Shear Force, Va = 106.4259
EDGE -B-
Bending Moment, Mb = -110881.122
Shear Force, Vb = -106.4259
BOTH EDGES
Axial Force, F = -21691.294
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
   -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 1539.38
   -Compression: Asl,com = 2475.575
       -Middle: Asl,mid = 2676.637
Mean Diameter of Tension Reinforcement, DbL,ten = 16.57143

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 1.1072E+006
Vn ((10.3), ASCE 41-17) = knl*VColO = 1.1072E+006
   VCol = 1.1072E+006
   knl = 1.00
      displacement_ductility_demand = 0.0066332

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 = 3.2486
      Mu = 207441.237
      Vu = 106.4259
   d = 0.8*h = 600.00
   Nu = 21691.294
   Ag = 337500.00
   From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 842449.486
   where:
   Vs,jacket = Vs,j1 + Vs,j2 = 753982.237
   Vs,j1 = 471238.898 is calculated for section web jacket, with:
      d = 600.00
      Av = 157079.633
      fy = 500.00
      s = 100.00
   Vs,j1 is multiplied by   Col,j1 = 1.00
      s/d = 0.16666667
   Vs,j2 = 282743.339 is calculated for section flange jacket, with:
      d = 360.00
      Av = 157079.633
      fy = 500.00
      s = 100.00
   Vs,j2 is multiplied by   Col,j2 = 1.00
      s/d = 0.27777778
   Vs,core = Vs,c1 + Vs,c2 = 88467.249
   Vs,c1 = 88467.249 is calculated for section web core, with:
      d = 440.00

Av = 100530.965
      fy = 500.00
      s = 250.00
   Vs,c1 is multiplied by   Col,c1 = 1.00
      s/d = 0.56818182
   Vs,c2 = 0.00 is calculated for section flange core, with:
      d = 200.00
      Av = 100530.965
      fy = 500.00
      s = 250.00
   Vs,c2 is multiplied by   Col,c2 = 0.00
      s/d = 1.25
   Vf ((11-3)-(11.4), ACI 440) = 463792.00
      f = 0.95, for fully-wrapped sections
   wf/sf = 1 (FRP strips adjacent to one another).
   In (11.3) sin + cos is replaced with (cot +cota)sina which is more a generalised expression,
   where   is the angle of the crack direction (see KANEPE).
   This later relation, considered as a function Vf(,), is implemented for every different fiber orientation ai,
   as well as for 2 crack directions, =45° and =-45° to take into consideration the cyclic seismic loading.
   orientation 1:   1 = b1 + 90° = 90.00
   Vf = Min(|Vf(45, 1)|,|Vf(-45,a1)|), with:
   total thickness per orientation, tf1 = NL*t/NoDir = 1.00
   dfv = d (figure 11.2, ACI 440) = 707.00
   ffe ((11-5), ACI 440) = 328.00
      Ef = 82000.00
       fe = 0.004, from (11.6a), ACI 440
         with fu = 0.009
   From (11-11), ACI 440: Vs + Vf <= 896810.169
      bw = 450.00

----
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   = 1.1520951E-005
 y = (My*Ls/3)/EIeff = 0.00173686 ((4.29),Biskinis Phd))
  My = 4.9054E+008
  Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1949.161
  From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.8350E+014
     factor = 0.30
        Ag = 562500.00
        Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
        N = 21691.294
     Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 6.1166E+014

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 = 950.00
web width, bw = 450.00
flange thickness, t = 450.00
----
  y = Min(y_ten, y_com)
  y_ten = 2.7530492E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 311.2112
    d = 707.00
     y = 0.20054914
    A = 0.01006669
    B = 0.00473366
     with pt = 0.00229194

```
         pc = 0.00368581
         pv = 0.00398517
         N = 21691.294
         b = 950.00
          " = 0.06082037
    y_comp = 1.5813155E-005
 with fc* (12.3, (ACI 440)) = 33.31981
      fc = 33.00
      fl = 0.5419822
      b = bmax = 950.00
      h = hmax = 750.00
      Ag = 0.5625
         g = pt + pc + pv = 0.00996292
        rc = 40.00
        Ae/Ac = 0.30198841
        Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
      effective strain from (12.5) and (12.12), efe = 0.004
       fu = 0.009
      Ef = 82000.00
     Ec = 26999.444
      y = 0.19869284
     A = 0.00989022
     B = 0.00462988
      with Es = 200000.00
 CONFIRMATION:  y = 0.19956371 < t/d
 -----------------------------------------------------------
 -----------------------------------------------------------

 Calculation of ratio lb/ld
 -----------------------------------------------------------
 Inadequate Lap Length with lb/ld = 0.30
 -----------------------------------------------------------
 End Of Calculation of Shear Capacity for element: column JTC1 of floor 1
 At local axis: 3
 Integration Section: (a)

 -----------------------------------------------------------
```
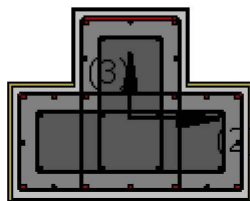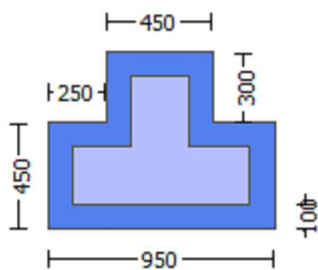
Calculation No. 12

column C1, Floor 1

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

Analysis: Uniform +X

Check: Chord rotation capacity (u)

Edge: Start

Local Axis: (3)

Start Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcjtcs

Constant Properties

Knowledge Factor,   = 0.80
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
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 = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
###
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.02727
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°

Number of layers, NL = 1
Radius of rounding corners, R = 40.00

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = -2.5087409E-020
EDGE -B-
Shear Force, Vb = 2.5087409E-020
BOTH EDGES
Axial Force, F = -20792.022
Longitudinal Reinforcement Area Distribution (in 2 divisions)
    -Tension: Aslt = 0.00
  -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
    -Tension: Asl,ten = 1539.38
   -Compression: Asl,com = 2475.575
    -Middle: Asl,mid = 2676.637

Calculation of Shear Capacity ratio , Ve/Vr = 0.44505685
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 632982.444
with
Mpr1 = Max(Mu1+ , Mu1-) = 9.4947E+008
  Mu1+ = 6.7087E+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- = 9.4947E+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-) = 9.4947E+008
  Mu2+ = 6.7087E+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- = 9.4947E+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 = 8.5351751E-006
Mu = 6.7087E+008
----
with full section properties:
 b = 950.00
 d = 707.00
 d' = 43.00
 v = 0.00093808
  N = 20792.022
 fc = 33.00
  εco (5A.5, TBDY) = 0.002
 Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.0116768
  The Shear_factor is considered equal to 1 (pure moment strength)
  From (5.4b), TBDY: εcu = 0.0116768
   ωwe ((5.4c), TBDY) = αse* ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.04178759
  where ωf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

   ωfx = 0.02973616
  Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
  αf = 0.28545185
  with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
   bmax = 950.00

hmax = 750.00
From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
   bw = 450.00
effective stress from (A.35), ff,e = 773.4788

----

 fy = 0.02973616
Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
af = 0.28545185
with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
   bmax = 950.00
   hmax = 750.00
   From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
      bw = 450.00
   effective stress from (A.35), ff,e = 773.4788

 R = 40.00
 Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
 fu,f = 840.00
 Ef = 82000.00
  u,f = 0.015
 ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
    ase1 = Max((((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
    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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
    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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
 psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
    Lstir1 (Length of stirrups along Y) = 2160.00
    Astir1 (stirrups area) = 78.53982
 psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
    Lstir2 (Length of stirrups along Y) = 1568.00
    Astir2 (stirrups area) = 50.26548

----

 psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
 psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
    Lstir1 (Length of stirrups along X) = 2560.00
    Astir1 (stirrups area) = 78.53982
 psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
    Lstir2 (Length of stirrups along X) = 1968.00
    Astir2 (stirrups area) = 50.26548

    Asec = 562500.00
    s1 = 100.00

```
       s2 = 250.00
      fywe1 = 694.45
      fywe2 = 694.45
       fce = 33.00
    From ((5.A5), TBDY), TBDY:  cc = 0.00227274
        c = confinement factor = 1.02727
  y1 = 0.00140044
  sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
  su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
     su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
     with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
     with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.00140044
  sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
  su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.30
     su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
     with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
     with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00140044
  shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
  suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
     suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and  yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
     with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
     with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.02701806
    2 = Asl,com/(b*d)*(fs2/fc) = 0.04344945
    v = Asl,mid/(b*d)*(fsv/fc) = 0.04697834
and confined core properties:
  b = 890.00
  d = 677.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.90003
   cc (5A.5, TBDY) = 0.00227274
      c = confinement factor = 1.02727
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.03011747
    2 = Asl,com/(b*d)*(fs2/fc) = 0.04843381
```

v = Asl,mid/(b*d)*(fsv/fc) = 0.05236752
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.15152684
Mu = MRc (4.14) = 6.7087E+008
  u =   su (4.1) = 8.5351751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 9.2428803E-006
Mu = 9.4947E+008
----
with full section properties:
  b = 450.00
  d = 707.00
  d' = 43.00
  v = 0.00198039
    N = 20792.022
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.0116768
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx,   fy) = 0.04178759
    where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----
      fx = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788
    ----
      fy = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788

      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
      fu,f = 840.00
      Ef = 82000.00
       u,f = 0.015
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
        ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
        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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
 Lstir1 (Length of stirrups along Y) = 2160.00
 Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
 Lstir2 (Length of stirrups along Y) = 1568.00
 Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
 Lstir1 (Length of stirrups along X) = 2560.00
 Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
 Lstir2 (Length of stirrups along X) = 1968.00
 Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00227274
c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044

sh2 = 0.0044814
  ft2 = 466.8167
  fy2 = 389.0139
   su2 = 0.00512
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/lb,min = 0.30
      su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esu2_nominal = 0.08,
     For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
     characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
       with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
       with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
   yv = 0.00140044
   shv = 0.0044814
  ftv = 466.8167
  fyv = 389.0139
   suv = 0.00512
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/ld = 0.30
      suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esuv_nominal = 0.08,
     considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
     For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
     characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
       with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
       with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.09172662
     2 = Asl,com/(b*d)*(fs2/fc) = 0.05703813
     v = Asl,mid/(b*d)*(fsv/fc) = 0.0991765
and confined core properties:
   b = 390.00
   d = 677.00
   d' = 13.00
  fcc (5A.2, TBDY) = 33.90003
   cc (5A.5, TBDY) = 0.00227274
      c = confinement factor = 1.02727
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.11052844
     2 = Asl,com/(b*d)*(fs2/fc) = 0.06872961
     v = Asl,mid/(b*d)*(fsv/fc) = 0.11950537
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.21649239
Mu = MRc (4.14) = 9.4947E+008
  u =   su (4.1) = 9.2428803E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 8.5351751E-006

Mu = 6.7087E+008

----

with full section properties:
  b = 950.00
  d = 707.00
  d' = 43.00
  v = 0.00093808
     N = 20792.022
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: cu = 0.0116768
       we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.04178759
     where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
     ----
       fx = 0.02973616
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
       bmax = 950.00
       hmax = 750.00
       From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
         bw = 450.00
       effective stress from (A.35), ff,e = 773.4788
     ----
       fy = 0.02973616
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
       bmax = 950.00
       hmax = 750.00
       From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
         bw = 450.00
       effective stress from (A.35), ff,e = 773.4788

       R = 40.00
       Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
       fu,f = 840.00
       Ef = 82000.00
        u,f = 0.015
       ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
         ase1 = Max((((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
         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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
         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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363

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 = 2.48363
    psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
        Lstir1 (Length of stirrups along Y) = 2160.00
        Astir1 (stirrups area) = 78.53982
    psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
        Lstir2 (Length of stirrups along Y) = 1568.00
        Astir2 (stirrups area) = 50.26548

----
    psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
    psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
        Lstir1 (Length of stirrups along X) = 2560.00
        Astir1 (stirrups area) = 78.53982
    psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
        Lstir2 (Length of stirrups along X) = 1968.00
        Astir2 (stirrups area) = 50.26548

        Asec = 562500.00
        s1 = 100.00
        s2 = 250.00
    fywe1 = 694.45
    fywe2 = 694.45
    fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00227274
        c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
      with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
      with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.30
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
      with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
      with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00

lo/lou,min = lb/ld = 0.30
 suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
 y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
 with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
 with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.02701806
2 = Asl,com/(b*d)*(fs2/fc) = 0.04344945
v = Asl,mid/(b*d)*(fsv/fc) = 0.04697834
and confined core properties:
 b = 890.00
 d = 677.00
 d' = 13.00
 fcc (5A.2, TBDY) = 33.90003
  cc (5A.5, TBDY) = 0.00227274
   c = confinement factor = 1.02727
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.03011747
  2 = Asl,com/(b*d)*(fs2/fc) = 0.04843381
  v = Asl,mid/(b*d)*(fsv/fc) = 0.05236752
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.15152684
Mu = MRc (4.14) = 6.7087E+008
 u = su (4.1) = 8.5351751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 u = 9.2428803E-006
Mu = 9.4947E+008
----
with full section properties:
 b = 450.00
 d = 707.00
 d' = 43.00
 v = 0.00198039
  N = 20792.022
 fc = 33.00
  co (5A.5, TBDY) = 0.002
 Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768
   The Shear_factor is considered equal to 1 (pure moment strength)
   From (5.4b), TBDY: cu = 0.0116768
    we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.04178759
   where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
   ----
    fx = 0.02973616
   Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
   af = 0.28545185
   with Unconfined area = ((bmax-2R)^2+ (hmax-2R)^2)/3 = 160566.667
    bmax = 950.00
    hmax = 750.00
    From EC8 A 4.4.3(6), pf = 2tf/bw = 0.00444444

bw = 450.00
         effective stress from (A.35), ff,e = 773.4788
   ----
      fy = 0.02973616
   Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
   af = 0.28545185
   with Unconfined area = ((bmax-2R)^2+ (hmax-2R)^2)/3 = 160566.667
         bmax = 950.00
         hmax = 750.00
         From EC8 A4.4.3(6), pf = 2tf/bw = 0.00444444
            bw = 450.00
         effective stress from (A.35), ff,e = 773.4788

      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
      fu,f = 840.00
      Ef = 82000.00
       u,f = 0.015
      ase ((5.4d), TBDY) = (ase1*Aext+ ase2*Aint)/Asec = 0.53375773
         ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
         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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
         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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
   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 = 2.48363
      psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
         Lstir1 (Length of stirrups along Y) = 2160.00
         Astir1 (stirrups area) = 78.53982
      psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
         Lstir2 (Length of stirrups along Y) = 1568.00
         Astir2 (stirrups area) = 50.26548
   ----
      psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
      psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
         Lstir1 (Length of stirrups along X) = 2560.00
         Astir1 (stirrups area) = 78.53982
      psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
         Lstir2 (Length of stirrups along X) = 1968.00
         Astir2 (stirrups area) = 50.26548

      Asec = 562500.00
      s1 = 100.00
      s2 = 250.00
   fywe1 = 694.45

```
        fywe2 = 694.45
        fce  = 33.00
    From ((5.A5), TBDY), TBDY:  cc = 0.00227274
        c  = confinement factor = 1.02727
  y1 = 0.00140044
  sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
  su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
      su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
      with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
      with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.00140044
  sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
  su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.30
      su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
      with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
      with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00140044
  shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
  suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
      suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and  yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
      with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
      with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.09172662
  2 = Asl,com/(b*d)*(fs2/fc) = 0.05703813
  v = Asl,mid/(b*d)*(fsv/fc) = 0.0991765
and confined core properties:
  b = 390.00
  d = 677.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.90003
  cc (5A.5, TBDY) = 0.00227274
      c  = confinement factor = 1.02727
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.11052844
    2 = Asl,com/(b*d)*(fs2/fc) = 0.06872961
    v = Asl,mid/(b*d)*(fsv/fc) = 0.11950537
Case/Assumption: Unconfinesd full section - Steel rupture
```

' satisfies Eq. (4.3)

--->

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

--->

su (4.9) = 0.21649239

Mu = MRc (4.14) = 9.4947E+008

u = su (4.1) = 9.2428803E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.4223E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.4223E+006

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

   VCol0 = 1.4223E+006

   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 = 33.00, but fc^0.5 <= 8.3

MPa (22.5.3.1, ACI 318-14)

   M/Vd = 2.00

      Mu = 1533.833

      Vu = 2.5087409E-020

   d = 0.8*h = 600.00

   Nu = 20792.022

   Ag = 337500.00

   From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 936062.473

   where:

   Vs,jacket = Vs,j1 + Vs,j2 = 837764.743

   Vs,j1 = 523602.964 is calculated for section web jacket, with:

      d = 600.00

      Av = 157079.633

      fy = 555.56

      s = 100.00

   Vs,j1 is multiplied by Col,j1 = 1.00

      s/d = 0.16666667

   Vs,j2 = 314161.779 is calculated for section flange jacket, with:

      d = 360.00

      Av = 157079.633

      fy = 555.56

      s = 100.00

   Vs,j2 is multiplied by Col,j2 = 1.00

      s/d = 0.27777778

   Vs,core = Vs,c1 + Vs,c2 = 98297.73

   Vs,c1 = 98297.73 is calculated for section web core, with:

      d = 440.00

      Av = 100530.965

      fy = 555.56

      s = 250.00

   Vs,c1 is multiplied by Col,c1 = 1.00

      s/d = 0.56818182

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

      d = 200.00

      Av = 100530.965

      fy = 555.56

      s = 250.00

   Vs,c2 is multiplied by Col,c2 = 0.00

      s/d = 1.25

Vf ((11-3)-(11.4), ACI 440) = 463792.00
   ϕf = 0.95, for fully-wrapped sections
  wf/sf = 1 (FRP strips adjacent to one another).
 In (11.3) sin α + cos α is replaced with (cot θ + cota)sina which is more a generalised expression,
 where θ is the angle of the crack direction (see KANEPE).
 This later relation, considered as a function Vf(θ, α), is implemented for every different fiber orientation ai,
 as well as for 2 crack directions, θ = 45° and θ = -45° to take into consideration the cyclic seismic loading.
 orientation 1: α_1 = b1 + 90° = 90.00
 Vf = Min(|Vf(45, α1)|, |Vf(-45,a1)|), with:
 total thickness per orientation, tf1 = NL*t/NoDir = 1.00
 dfv = d (figure 11.2, ACI 440) = 707.00
 ffe ((11-5), ACI 440) = 328.00
   Ef = 82000.00
    ϵfe = 0.004, from (11.6a), ACI 440
     with ϵfu = 0.009
  From (11-11), ACI 440: Vs + Vf <= 1.0304E+006
   bw = 450.00

Calculation of Shear Strength at edge 2, Vr2 = 1.4223E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
 VCol0 = 1.4223E+006
 knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ ϕf*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 = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
    Mu = 1533.833
    Vu = 2.5087409E-020
  d = 0.8*h = 600.00
  Nu = 20792.022
  Ag = 337500.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 936062.473
  where:
 Vs,jacket = Vs,j1 + Vs,j2 = 837764.743
 Vs,j1 = 523602.964 is calculated for section web jacket, with:
   d = 600.00
   Av = 157079.633
   fy = 555.56
   s = 100.00
 Vs,j1 is multiplied by λCol,j1 = 1.00
   s/d = 0.16666667
 Vs,j2 = 314161.779 is calculated for section flange jacket, with:
   d = 360.00
   Av = 157079.633
   fy = 555.56
   s = 100.00
 Vs,j2 is multiplied by λCol,j2 = 1.00
   s/d = 0.27777778
 Vs,core = Vs,c1 + Vs,c2 = 98297.73
 Vs,c1 = 98297.73 is calculated for section web core, with:
   d = 440.00
   Av = 100530.965
   fy = 555.56
   s = 250.00
 Vs,c1 is multiplied by λCol,c1 = 1.00
   s/d = 0.56818182
 Vs,c2 = 0.00 is calculated for section flange core, with:
   d = 200.00
   Av = 100530.965
   fy = 555.56
   s = 250.00
 Vs,c2 is multiplied by λCol,c2 = 0.00

s/d = 1.25
Vf ((11-3)-(11.4), ACI 440) = 463792.00
    f = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sin + cos is replaced with (cot +cota)sina which is more a generalised expression,
where is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(,), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, =45° and =-45° to take into consideration the cyclic seismic loading.
orientation 1: 1 = b1 + 90° = 90.00
Vf = Min(|Vf(45, 1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.00
dfv = d (figure 11.2, ACI 440) = 707.00
ffe ((11-5), ACI 440) = 328.00
    Ef = 82000.00
     fe = 0.004, from (11.6a), ACI 440
      with fu = 0.009
From (11-11), ACI 440: Vs + Vf <= 1.0304E+006
    bw = 450.00

End Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjtcs

Constant Properties

Knowledge Factor,   = 0.80
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
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 = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
##
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.02727
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = 5.4210109E-020
EDGE -B-
Shear Force, Vb = -5.4210109E-020
BOTH EDGES
Axial Force, F = -20792.022
Longitudinal Reinforcement Area Distribution (in 2 divisions)
       -Tension: Aslt = 0.00
     -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
       -Tension: Asl,ten = 1539.38
     -Compression: Asl,com = 1539.38
        -Middle: Asl,mid = 3612.832

Calculation of Shear Capacity ratio , Ve/Vr = 0.3589236
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 646212.952
with
Mpr1 = Max(Mu1+ , Mu1-) = 9.6932E+008
   Mu1+ = 9.6932E+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- = 9.6932E+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-) = 9.6932E+008
   Mu2+ = 9.6932E+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- = 9.6932E+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 = 6.9132751E-006
Mu = 9.6932E+008
----
with full section properties:
   b = 450.00
   d = 907.00
   d' = 43.00
   v = 0.0015437
      N = 20792.022
   fc = 33.00
    co (5A.5, TBDY) = 0.002

Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.0116768
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.04178759
    where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----
    fx = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788
    ----
    fy = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788

    R = 40.00
    Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
    fu,f = 840.00
    Ef = 82000.00
     u,f = 0.015
    ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
      ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
      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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
      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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
    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 = 2.48363
    psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
      Lstir1 (Length of stirrups along Y) = 2160.00
      Astir1 (stirrups area) = 78.53982
    psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
      Lstir2 (Length of stirrups along Y) = 1568.00
      Astir2 (stirrups area) = 50.26548

```
-------------------------------------------------------------------
    psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
    psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
       Lstir1 (Length of stirrups along X) = 2560.00
       Astir1 (stirrups area) = 78.53982
    psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
       Lstir2 (Length of stirrups along X) = 1968.00
       Astir2 (stirrups area) = 50.26548
-------------------------------------------------------------------
       Asec = 562500.00
       s1 = 100.00
       s2 = 250.00
     fywe1 = 694.45
     fywe2 = 694.45
     fce  = 33.00
   From ((5.A5), TBDY), TBDY:  cc = 0.00227274
       c  = confinement factor = 1.02727
  y1 = 0.00140044
  sh1 = 0.0044814
 ft1 = 466.8167
 fy1 = 389.0139
  su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
     su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
     with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
     with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.00140044
  sh2 = 0.0044814
 ft2 = 466.8167
 fy2 = 389.0139
  su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.30
     su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
     with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
     with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00140044
  shv = 0.0044814
 ftv = 466.8167
 fyv = 389.0139
  suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
     suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and  yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
     with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
     with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.04446081
```

  2 = Asl,com/(b*d)*(fs2/fc) = 0.04446081
  v = Asl,mid/(b*d)*(fsv/fc) = 0.1043468
and confined core properties:
 b = 390.00
 d = 877.00
 d' = 13.00
 fcc (5A.2, TBDY) = 33.90003
  cc (5A.5, TBDY) = 0.00227274
   c = confinement factor = 1.02727
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.05305581
  2 = Asl,com/(b*d)*(fs2/fc) = 0.05305581
  v = Asl,mid/(b*d)*(fsv/fc) = 0.12451875
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.18345742
Mu = MRc (4.14) = 9.6932E+008
 u = su (4.1) = 6.9132751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 u = 6.9132751E-006
Mu = 9.6932E+008
----
with full section properties:
 b = 450.00
 d = 907.00
 d' = 43.00
 v = 0.0015437
  N = 20792.022
 fc = 33.00
  co (5A.5, TBDY) = 0.002
 Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768
  The Shear_factor is considered equal to 1 (pure moment strength)
  From (5.4b), TBDY: cu = 0.0116768
   we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.04178759
  where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
  ----
   fx = 0.02973616
  Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
  af = 0.28545185
  with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
   bmax = 950.00
   hmax = 750.00
   From EC8 A4.4.3(6), pf = 2tf/bw = 0.00444444
    bw = 450.00
   effective stress from (A.35), ff,e = 773.4788
  ----
   fy = 0.02973616
  Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
  af = 0.28545185
  with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
   bmax = 950.00
   hmax = 750.00
   From EC8 A4.4.3(6), pf = 2tf/bw = 0.00444444

```
         bw = 450.00
      effective stress from (A.35), ff,e = 773.4788
    ------------------------------------------------------------------
      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
      fu,f = 840.00
      Ef = 82000.00
       u,f = 0.015
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
         ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
         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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
         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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
    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 = 2.48363
      psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
         Lstir1 (Length of stirrups along Y) = 2160.00
         Astir1 (stirrups area) = 78.53982
      psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
         Lstir2 (Length of stirrups along Y) = 1568.00
         Astir2 (stirrups area) = 50.26548
    ------------------------------------------------------------------
      psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
      psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
         Lstir1 (Length of stirrups along X) = 2560.00
         Astir1 (stirrups area) = 78.53982
      psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
         Lstir2 (Length of stirrups along X) = 1968.00
         Astir2 (stirrups area) = 50.26548
    ------------------------------------------------------------------
      Asec = 562500.00
      s1 = 100.00
      s2 = 250.00
      fywe1 = 694.45
      fywe2 = 694.45
      fce  = 33.00
    From ((5.A5), TBDY), TBDY:  cc = 0.00227274
       c = confinement factor = 1.02727
   y1 = 0.00140044
  sh1 = 0.0044814
 ft1 = 466.8167
fy1 = 389.0139
 su1 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
```

and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
     su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
     with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
     with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.00140044
  sh2 = 0.0044814
 ft2 = 466.8167
 fy2 = 389.0139
  su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.30
     su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
     with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
     with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00140044
  shv = 0.0044814
 ftv = 466.8167
 fyv = 389.0139
  suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
     suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
     y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
     with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
     with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.04446081
    2 = Asl,com/(b*d)*(fs2/fc) = 0.04446081
    v = Asl,mid/(b*d)*(fsv/fc) = 0.1043468
and confined core properties:
  b = 390.00
  d = 877.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.90003
   cc (5A.5, TBDY) = 0.00227274
     c = confinement factor = 1.02727
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.05305581
    2 = Asl,com/(b*d)*(fs2/fc) = 0.05305581
    v = Asl,mid/(b*d)*(fsv/fc) = 0.12451875
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.18345742
Mu = MRc (4.14) = 9.6932E+008
  u =   su (4.1) = 6.9132751E-006

Calculation of ratio lb/ld

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

----------------------------------------------------------------------------
Calculation of ultimate curvature  u according to 4.1, Biskinis/Fardis 2013:
  u = 6.9132751E-006
Mu = 9.6932E+008
----------------------------------------------------------------------------
with full section properties:
  b = 450.00
  d = 907.00
  d' = 43.00
  v = 0.0015437
    N = 20792.022
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of  cu:  cu* = shear_factor * Max( cu, cc) = 0.0116768
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY:  cu = 0.0116768
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min( fx,  fy) = 0.04178759
    where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----------------------------------------------------------------
      fx = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788
    ----------------------------------------------------------------
      fy = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788
    ----------------------------------------------------------------
      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
      fu,f = 840.00
      Ef = 82000.00
       u,f = 0.015
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
        ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
        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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
        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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
   Lstir1 (Length of stirrups along Y) = 2160.00
   Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
   Lstir2 (Length of stirrups along Y) = 1568.00
   Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
   Lstir1 (Length of stirrups along X) = 2560.00
   Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
   Lstir2 (Length of stirrups along X) = 1968.00
   Astir2 (stirrups area) = 50.26548

   Asec = 562500.00
   s1 = 100.00
   s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00227274
   c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.30
   su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esu1_nominal = 0.08,
   For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
   characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
   y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
   with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
   with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/lb,min = 0.30
   su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esu2_nominal = 0.08,
   For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
   characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

य1, 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 = 389.0139
  with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
  suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esuv_nominal = 0.08,
  considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
  For calculation of esuv_nominal and   yv, shv,ftv,fyv, it is considered
  characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
  with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04446081
2 = Asl,com/(b*d)*(fs2/fc) = 0.04446081
v = Asl,mid/(b*d)*(fsv/fc) = 0.1043468
and confined core properties:
b = 390.00
d = 877.00
d' = 13.00
fcc (5A.2, TBDY) = 33.90003
cc (5A.5, TBDY) = 0.00227274
  c = confinement factor = 1.02727
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05305581
2 = Asl,com/(b*d)*(fs2/fc) = 0.05305581
v = Asl,mid/(b*d)*(fsv/fc) = 0.12451875
Case/Assumption: Unconfinesd full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.18345742
Mu = MRc (4.14) = 9.6932E+008
u =   su (4.1) = 6.9132751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
u = 6.9132751E-006
Mu = 9.6932E+008
----
with full section properties:
b = 450.00
d = 907.00
d' = 43.00
v = 0.0015437
  N = 20792.022
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768
  The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: cu = 0.0116768
  we ((5.4c), TBDY) = ase* sh,min*fywe/fce+ Min(fx, fy) = 0.04178759
where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----
  fx = 0.02973616
Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
af = 0.28545185
with Unconfined area = ((bmax-2R)^2+ (hmax-2R)^2)/3 = 160566.667
  bmax = 950.00
  hmax = 750.00
  From EC8 A 4.4.3(6), pf = 2tf/bw = 0.00444444
   bw = 450.00
  effective stress from (A.35), ff,e = 773.4788
----
  fy = 0.02973616
Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
af = 0.28545185
with Unconfined area = ((bmax-2R)^2+ (hmax-2R)^2)/3 = 160566.667
  bmax = 950.00
  hmax = 750.00
  From EC8 A 4.4.3(6), pf = 2tf/bw = 0.00444444
   bw = 450.00
  effective stress from (A.35), ff,e = 773.4788

  R = 40.00
  Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
  fu,f = 840.00
  Ef = 82000.00
   u,f = 0.015
  ase ((5.4d), TBDY) = (ase1*Aext+ ase2*Aint)/Asec = 0.53375773
    ase1 = Max((((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
    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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
    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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
  psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
    Lstir1 (Length of stirrups along Y) = 2160.00
    Astir1 (stirrups area) = 78.53982
  psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
    Lstir2 (Length of stirrups along Y) = 1568.00
    Astir2 (stirrups area) = 50.26548
----
  psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078

```
    psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
        Lstir1 (Length of stirrups along X) = 2560.00
        Astir1 (stirrups area) = 78.53982
    psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
        Lstir2 (Length of stirrups along X) = 1968.00
        Astir2 (stirrups area) = 50.26548
    -------------------------------------------------------------------
        Asec = 562500.00
        s1 = 100.00
        s2 = 250.00
      fywe1 = 694.45
      fywe2 = 694.45
      fce  = 33.00
    From ((5.A5), TBDY), TBDY:  cc = 0.00227274
        c  = confinement factor = 1.02727
  y1 = 0.00140044
  sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
  su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
      su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
      with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
      with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.00140044
  sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
  su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.30
      su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
      with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
      with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00140044
  shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
  suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
      suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and  yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
      with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
      with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.04446081
  2 = Asl,com/(b*d)*(fs2/fc) = 0.04446081
  v = Asl,mid/(b*d)*(fsv/fc) = 0.1043468
```

and confined core properties:
   b = 390.00
   d = 877.00
   d' = 13.00
   fcc (5A.2, TBDY) = 33.90003
    cc (5A.5, TBDY) = 0.00227274
        c = confinement factor = 1.02727
      1 = Asl,ten/(b*d)*(fs1/fc) = 0.05305581
      2 = Asl,com/(b*d)*(fs2/fc) = 0.05305581
      v = Asl,mid/(b*d)*(fsv/fc) = 0.12451875
Case/Assumption: Unconfinesd full section - Steel rupture
   ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
  su (4.9) = 0.18345742
Mu = MRc (4.14) = 9.6932E+008
  u =   su (4.1) = 6.9132751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.8004E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.8004E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
   VCol0 = 1.8004E+006
   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 = 33.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
   M/Vd = 2.00
       Mu = 1.22911
       Vu = 5.4210109E-020
   d = 0.8*h = 760.00
   Nu = 20792.022
   Ag = 427500.00
   From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 1.1114E+006
   where:
   Vs,jacket = Vs,j1 + Vs,j2 = 977392.20
   Vs,j1 = 314161.779 is calculated for section web jacket, with:
      d = 360.00
      Av = 157079.633
      fy = 555.56
      s = 100.00
   Vs,j1 is multiplied by   Col,j1 = 1.00
      s/d = 0.27777778
   Vs,j2 = 663230.422 is calculated for section flange jacket, with:
      d = 760.00
      Av = 157079.633
      fy = 555.56
      s = 100.00
   Vs,j2 is multiplied by   Col,j2 = 1.00
      s/d = 0.13157895
   Vs,core = Vs,c1 + Vs,c2 = 134042.359
   Vs,c1 = 0.00 is calculated for section web core, with:
      d = 200.00
      Av = 100530.965

fy = 555.56
   s = 250.00
 Vs,c1 is multiplied by Col,c1 = 0.00
   s/d = 1.25
 Vs,c2 = 134042.359 is calculated for section flange core, with:
   d = 600.00
   Av = 100530.965
   fy = 555.56
   s = 250.00
 Vs,c2 is multiplied by Col,c2 = 1.00
   s/d = 0.41666667
 Vf ((11-3)-(11.4), ACI 440) = 594992.00
   f = 0.95, for fully-wrapped sections
 wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sin + cos is replaced with (cot +cota)sina which is more a generalised expression,
where is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(,), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, =45° and =-45° to take into consideration the cyclic seismic loading.
orientation 1: 1 = b1 + 90° = 90.00
Vf = Min(|Vf(45, 1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.00
dfv = d (figure 11.2, ACI 440) = 907.00
ffe ((11-5), ACI 440) = 328.00
  Ef = 82000.00
   fe = 0.004, from (11.6a), ACI 440
    with fu = 0.009
 From (11-11), ACI 440: Vs + Vf <= 1.3051E+006
  bw = 450.00

Calculation of Shear Strength at edge 2, Vr2 = 1.8004E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
 VCol0 = 1.8004E+006
 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 = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
 M/Vd = 2.00
  Mu = 1.22911
  Vu = 5.4210109E-020
 d = 0.8*h = 760.00
 Nu = 20792.022
 Ag = 427500.00
 From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 1.1114E+006
 where:
Vs,jacket = Vs,j1 + Vs,j2 = 977392.20
 Vs,j1 = 314161.779 is calculated for section web jacket, with:
  d = 360.00
  Av = 157079.633
  fy = 555.56
  s = 100.00
 Vs,j1 is multiplied by Col,j1 = 1.00
  s/d = 0.27777778
 Vs,j2 = 663230.422 is calculated for section flange jacket, with:
  d = 760.00
  Av = 157079.633
  fy = 555.56
  s = 100.00
 Vs,j2 is multiplied by Col,j2 = 1.00
  s/d = 0.13157895
Vs,core = Vs,c1 + Vs,c2 = 134042.359
 Vs,c1 = 0.00 is calculated for section web core, with:
  d = 200.00

Av = 100530.965
        fy = 555.56
        s = 250.00
    Vs,c1 is multiplied by   Col,c1 = 0.00
        s/d = 1.25
    Vs,c2 = 134042.359 is calculated for section flange core, with:
        d = 600.00
        Av = 100530.965
        fy = 555.56
        s = 250.00
    Vs,c2 is multiplied by   Col,c2 = 1.00
        s/d = 0.41666667
    Vf ((11-3)-(11.4), ACI 440) = 594992.00
        f = 0.95, for fully-wrapped sections
    wf/sf = 1 (FRP strips adjacent to one another).
    In (11.3) sin + cos is replaced with (cot +cota)sina which is more a generalised expression,
    where   is the angle of the crack direction (see KANEPE).
    This later relation, considered as a function Vf(,), is implemented for every different fiber orientation ai,
    as well as for 2 crack directions, =45° and =-45° to take into consideration the cyclic seismic loading.
    orientation 1:   1 = b1 + 90° = 90.00
    Vf = Min(|Vf(45, 1)|,|Vf(-45,a1)|), with:
    total thickness per orientation, tf1 = NL*t/NoDir = 1.00
    dfv = d (figure 11.2, ACI 440) = 907.00
    ffe ((11-5), ACI 440) = 328.00
        Ef = 82000.00
        fe = 0.004, from (11.6a), ACI 440
          with fu = 0.009
    From (11-11), ACI 440: Vs + Vf <= 1.3051E+006
        bw = 450.00

End Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column JTC1 of floor 1
At local axis: 3
Integration Section: (a)
Section Type: rcjtcs

Constant Properties

Knowledge Factor,   = 0.80
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 Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member

Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lb/ld = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

Stepwise Properties

Bending Moment, M = -2.4188E+007
Shear Force, V2 = -7990.756
Shear Force, V3 = 106.4259
Axial Force, F = -21691.294
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
   -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 1539.38
   -Compression: Asl,com = 1539.38
      -Middle: Asl,mid = 3612.832
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten,jacket = 1231.504
   -Compression: Asl,com,jacket = 1231.504
      -Middle: Asl,mid,jacket = 2689.203
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten,core = 307.8761
   -Compression: Asl,com,core = 307.8761
      -Middle: Asl,mid,core = 923.6282
Mean Diameter of Tension Reinforcement, DbL = 16.57143

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $\theta u,R = 1.0* \theta u = 0.03244$
 $\theta u = \theta y + \theta p = 0.03244$

 - Calculation of θy -

 $\theta y = (My*Ls/3)/EIeff = 0.00244$ ((4.29),Biskinis Phd))
 $My = 6.7438E+008$
 $Ls = M/V$ (with Ls >0.1*L and Ls < 2*L) = 3027.037
 From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 2.7887E+014
   factor = 0.30
      Ag = 562500.00
      Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
      N = 21691.294
   Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 9.2958E+014

Calculation of Yielding Moment My

Calculation of θy and My according to Annex 7 -

 $\theta y = Min(\theta y\_ten, \theta y\_com)$

y_ten = 2.3115293E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 311.2112
    d = 907.00
    y = 0.25780424
    A = 0.0165657
    B = 0.00875687
     with pt = 0.0037716
        pc = 0.0037716
        pv = 0.00885172
        N = 21691.294
        b = 450.00
         " = 0.04740904
  y_comp = 9.5684630E-006
 with fc* (12.3, (ACI 440)) = 33.31497
    fc = 33.00
    fl = 0.5419822
    b = bmax = 950.00
    h = hmax = 750.00
    Ag = 0.5625
       g = pt + pc + pv = 0.01639493
       rc = 40.00
       Ae/Ac = 0.29742395
       Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
    effective strain from (12.5) and (12.12), efe = 0.004
     fu = 0.009
    Ef = 82000.00
    Ec = 26999.444
     y = 0.25592203
    A = 0.01627529
    B = 0.0085861
     with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

 - Calculation of p -

From table 10-8: p = 0.03
with:
 - Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
   shear control ratio VyE/VCol0E = 0.3589236
  d = d_external = 907.00
  s = s_external = 0.00
 - t = s1 + s2 + 2*tf/bw*(ffe/fs) = 0.00690186
  jacket: s1 = Av1*Lstir1/(s1*Ag) = 0.00357443
        Av1 = 78.53982, is the area of every stirrup parallel to loading (shear) direction
        Lstir1 = 2560.00, is the total Length of all stirrups parallel to loading (shear) direction
        s1 = 100.00
  core: s2 = Av2*Lstir2/(s2*Ag) = 0.00070345
        Av2 = 50.26548, is the area of every stirrup parallel to loading (shear) direction
        Lstir2 = 1968.00, 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 = 21691.294
   Ag = 562500.00
   f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 33.00
   fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein = 555.56
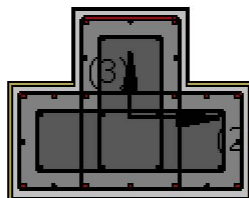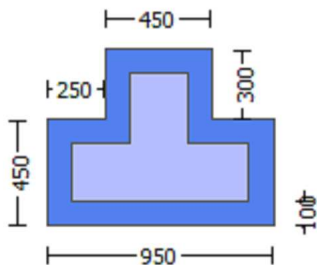   fytE = (fy_ext_Trans_Reinf* s1+fy_int_Trans_Reinf* s2)/(s1+ s2) = 555.56
 pl = Area_Tot_Long_Rein/(b*d) = 0.01639493

b = 450.00
d = 907.00
f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column JTC1 of floor 1
At local axis: 3
Integration Section: (a)

Calculation No. 13

column C1, Floor 1

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

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (2)

Start Of Calculation of Shear Capacity for element: column JTC1 of floor 1
At local axis: 2
Integration Section: (b)
Section Type: rcjtcs

Constant Properties

Knowledge Factor,   = 0.80
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 Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column

New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
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 = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
##
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min =lb/ld = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -2.4188E+007
Shear Force, Va = -7990.756
EDGE -B-
Bending Moment, Mb = 211408.354
Shear Force, Vb = 7990.756
BOTH EDGES
Axial Force, F = -21691.294
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1539.38
     -Compression: Asl,com = 1539.38
         -Middle: Asl,mid = 3612.832
Mean Diameter of Tension Reinforcement, DbL,ten = 16.57143

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 1.5678E+006
Vn ((10.3), ASCE 41-17) = knl*VColO = 1.5678E+006
   VCol = 1.5678E+006

knl = 1.00
  displacement_ductility_demand = 0.05469557

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 = 2.00
  Mu = 211408.354
  Vu = 7990.756
 d = 0.8*h = 760.00
 Nu = 21691.294
 Ag = 427500.00
 From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 1.0003E+006
 where:
 Vs,jacket = Vs,j1 + Vs,j2 = 879645.943
 Vs,j1 = 282743.339 is calculated for section web jacket, with:
  d = 360.00
  Av = 157079.633
  fy = 500.00
  s = 100.00
 Vs,j1 is multiplied by Col,j1 = 1.00
  s/d = 0.27777778
 Vs,j2 = 596902.604 is calculated for section flange jacket, with:
  d = 760.00
  Av = 157079.633
  fy = 500.00
  s = 100.00
 Vs,j2 is multiplied by Col,j2 = 1.00
  s/d = 0.13157895
 Vs,core = Vs,c1 + Vs,c2 = 120637.158
 Vs,c1 = 0.00 is calculated for section web core, with:
  d = 200.00
  Av = 100530.965
  fy = 500.00
  s = 250.00
 Vs,c1 is multiplied by Col,c1 = 0.00
  s/d = 1.25
 Vs,c2 = 120637.158 is calculated for section flange core, with:
  d = 600.00
  Av = 100530.965
  fy = 500.00
  s = 250.00
 Vs,c2 is multiplied by Col,c2 = 1.00
  s/d = 0.41666667
 Vf ((11-3)-(11.4), ACI 440) = 594992.00
  f = 0.95, for fully-wrapped sections
 wf/sf = 1 (FRP strips adjacent to one another).
 In (11.3) sin + cos is replaced with (cot +cota)sina which is more a generalised expression,
 where is the angle of the crack direction (see KANEPE).
 This later relation, considered as a function Vf(,), is implemented for every different fiber orientation ai,
 as well as for 2 crack directions, =45° and =-45° to take into consideration the cyclic seismic loading.
 orientation 1: 1 = b1 + 90° = 90.00
 Vf = Min(|Vf(45, 1)|,|Vf(-45,a1)|), with:
 total thickness per orientation, tf1 = NL*t/NoDir = 1.00
 dfv = d (figure 11.2, ACI 440) = 907.00
 ffe ((11-5), ACI 440) = 328.00
  Ef = 82000.00
  fe = 0.004, from (11.6a), ACI 440
   with fu = 0.009
 From (11-11), ACI 440: Vs + Vf <= 1.1360E+006
  bw = 450.00

----

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   = 1.3226545E-005
 y = (My*Ls/3)/Eleff = 0.00024182 ((4.29),Biskinis Phd))
  My = 6.7438E+008
  Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 300.00
  From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 2.7887E+014
    factor = 0.30
      Ag = 562500.00
      Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
      N = 21691.294
    Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 9.2958E+014

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7   -
----
 y = Min(y_ten, y_com)
 y_ten = 2.3115293E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 311.2112
    d = 907.00
     y = 0.25780424
    A = 0.0165657
    B = 0.00875687
     with pt = 0.0037716
        pc = 0.0037716
        pv = 0.00885172
        N = 21691.294
        b = 450.00
        " = 0.04740904
  y_comp = 9.5684630E-006
 with fc* (12.3, (ACI 440)) = 33.31497
    fc = 33.00
    fl = 0.5419822
    b = bmax = 950.00
    h = hmax = 750.00
    Ag = 0.5625
      g = pt + pc + pv = 0.01639493
      rc = 40.00
      Ae/Ac = 0.29742395
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
    effective strain from (12.5) and (12.12), efe = 0.004
     fu = 0.009
    Ef = 82000.00
   Ec = 26999.444
     y = 0.25592203
    A = 0.01627529
    B = 0.0085861
     with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

End Of Calculation of Shear Capacity for element: column JTC1 of floor 1
At local axis: 2
Integration Section: (b)

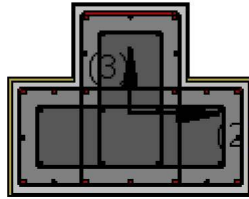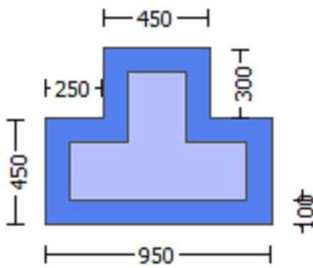
Calculation No. 14

column C1, Floor 1

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

Analysis: Uniform +X

Check: Chord rotation capacity (u)

Edge: End

Local Axis: (2)

Start Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcjtcs

Constant Properties

Knowledge Factor,   = 0.80
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
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 = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
###
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00

Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.02727
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = -2.5087409E-020
EDGE -B-
Shear Force, Vb = 2.5087409E-020
BOTH EDGES
Axial Force, F = -20792.022
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1539.38
     -Compression: Asl,com = 2475.575
        -Middle: Asl,mid = 2676.637

Calculation of Shear Capacity ratio , Ve/Vr = 0.44505685
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 632982.444
with
Mpr1 = Max(Mu1+ , Mu1-) = 9.4947E+008
   Mu1+ = 6.7087E+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- = 9.4947E+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-) = 9.4947E+008
   Mu2+ = 6.7087E+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- = 9.4947E+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 = 8.5351751E-006
Mu = 6.7087E+008
----
with full section properties:
  b = 950.00
  d = 707.00
  d' = 43.00
  v = 0.00093808
   N = 20792.022
  fc = 33.00
  co (5A.5, TBDY) = 0.002
  Final value of cu: cu^* = shear_factor * Max(cu, cc) = 0.0116768
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.0116768
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.04178759
    where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----
      fx = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788
    ----
      fy = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788

      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
      fu,f = 840.00
      Ef = 82000.00
      u,f = 0.015
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
        ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
        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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
        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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
    psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
       Lstir1 (Length of stirrups along Y) = 2160.00
       Astir1 (stirrups area) = 78.53982
    psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
       Lstir2 (Length of stirrups along Y) = 1568.00
       Astir2 (stirrups area) = 50.26548

    ----------------------------------------------------------------
    psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
    psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
       Lstir1 (Length of stirrups along X) = 2560.00
       Astir1 (stirrups area) = 78.53982
    psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
       Lstir2 (Length of stirrups along X) = 1968.00
       Astir2 (stirrups area) = 50.26548

    ----------------------------------------------------------------
    Asec = 562500.00
    s1 = 100.00
    s2 = 250.00
    fywe1 = 694.45
    fywe2 = 694.45
    fce  = 33.00
  From ((5.A5), TBDY), TBDY:  cc = 0.00227274
      c = confinement factor = 1.02727
 y1 = 0.00140044
 sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
 su1 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.30
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esu1_nominal = 0.08,
   For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
   characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
 y2 = 0.00140044
 sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
 su2 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/lb,min = 0.30
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esu2_nominal = 0.08,
   For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
   characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
 yv = 0.00140044
 shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
 suv = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
```

Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
 suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
 y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
 with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
 with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.02701806
2 = Asl,com/(b*d)*(fs2/fc) = 0.04344945
v = Asl,mid/(b*d)*(fsv/fc) = 0.04697834
and confined core properties:
  b = 890.00
  d = 677.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.90003
   cc (5A.5, TBDY) = 0.00227274
     c = confinement factor = 1.02727
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.03011747
    2 = Asl,com/(b*d)*(fs2/fc) = 0.04843381
    v = Asl,mid/(b*d)*(fsv/fc) = 0.05236752
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.15152684
Mu = MRc (4.14) = 6.7087E+008
  u =   su (4.1) = 8.5351751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
  u = 9.2428803E-006
Mu = 9.4947E+008
----
with full section properties:
  b = 450.00
  d = 707.00
  d' = 43.00
  v = 0.00198039
    N = 20792.022
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.0116768
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx,   fy) = 0.04178759
    where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----
      fx = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00

From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
   bw = 450.00
effective stress from (A.35), ff,e = 773.4788
----
  fy = 0.02973616
Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
af = 0.28545185
with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
  bmax = 950.00
  hmax = 750.00
  From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
   bw = 450.00
  effective stress from (A.35), ff,e = 773.4788

  R = 40.00
  Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
  fu,f = 840.00
  Ef = 82000.00
  u,f = 0.015
  ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
   ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
   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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
   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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
  psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
   Lstir1 (Length of stirrups along Y) = 2160.00
   Astir1 (stirrups area) = 78.53982
  psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
   Lstir2 (Length of stirrups along Y) = 1568.00
   Astir2 (stirrups area) = 50.26548
----
  psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
  psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
   Lstir1 (Length of stirrups along X) = 2560.00
   Astir1 (stirrups area) = 78.53982
  psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
   Lstir2 (Length of stirrups along X) = 1968.00
   Astir2 (stirrups area) = 50.26548

  Asec = 562500.00
  s1 = 100.00
  s2 = 250.00

fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00227274
    c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.30
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.09172662
    2 = Asl,com/(b*d)*(fs2/fc) = 0.05703813
    v = Asl,mid/(b*d)*(fsv/fc) = 0.0991765
and confined core properties:
    b = 390.00
    d = 677.00
    d' = 13.00
    fcc (5A.2, TBDY) = 33.90003
    cc (5A.5, TBDY) = 0.00227274
        c = confinement factor = 1.02727
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.11052844
    2 = Asl,com/(b*d)*(fs2/fc) = 0.06872961
    v = Asl,mid/(b*d)*(fsv/fc) = 0.11950537

Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.21649239
Mu = MRc (4.14) = 9.4947E+008
 u =   su (4.1) = 9.2428803E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 8.5351751E-006
Mu = 6.7087E+008
----
with full section properties:
  b = 950.00
  d = 707.00
  d' = 43.00
  v = 0.00093808
    N = 20792.022
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.0116768
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx,   fy) = 0.04178759
    where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----
      fx = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A4.4.3(6), pf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788
    ----
      fy = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A4.4.3(6), pf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788

      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
      fu,f = 840.00
      Ef = 82000.00
       u,f = 0.015
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
        ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
        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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00227274
c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814

ft2 = 466.8167
fy2 = 389.0139
 su2 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/lb,min = 0.30
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esu2_nominal = 0.08,
   For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
   characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00140044
  shv = 0.0044814
 ftv = 466.8167
 fyv = 389.0139
  suv = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.30
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esuv_nominal = 0.08,
   considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
   For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
   characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.02701806
  2 = Asl,com/(b*d)*(fs2/fc) = 0.04344945
  v = Asl,mid/(b*d)*(fsv/fc) = 0.04697834
and confined core properties:
  b = 890.00
  d = 677.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.90003
   cc (5A.5, TBDY) = 0.00227274
     c = confinement factor = 1.02727
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.03011747
   2 = Asl,com/(b*d)*(fs2/fc) = 0.04843381
   v = Asl,mid/(b*d)*(fsv/fc) = 0.05236752
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.15152684
Mu = MRc (4.14) = 6.7087E+008
 u =   su (4.1) = 8.5351751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 9.2428803E-006
Mu = 9.4947E+008

----
with full section properties:
  b = 450.00
  d = 707.00
  d' = 43.00
  v = 0.00198039
     N = 20792.022
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: cu = 0.0116768
       we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.04178759
     where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
     ----
       fx = 0.02973616
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
       bmax = 950.00
       hmax = 750.00
       From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
         bw = 450.00
       effective stress from (A.35), ff,e = 773.4788
     ----
       fy = 0.02973616
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
       bmax = 950.00
       hmax = 750.00
       From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
         bw = 450.00
       effective stress from (A.35), ff,e = 773.4788

       R = 40.00
       Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
       fu,f = 840.00
       Ef = 82000.00
        u,f = 0.015
       ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
         ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
         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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
         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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
     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 = 2.48363

     psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593

       Lstir1 (Length of stirrups along Y) = 2160.00

       Astir1 (stirrups area) = 78.53982

     psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047

       Lstir2 (Length of stirrups along Y) = 1568.00

       Astir2 (stirrups area) = 50.26548

----

     psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078

     psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443

       Lstir1 (Length of stirrups along X) = 2560.00

       Astir1 (stirrups area) = 78.53982

     psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345

       Lstir2 (Length of stirrups along X) = 1968.00

       Astir2 (stirrups area) = 50.26548

      Asec = 562500.00

      s1 = 100.00

      s2 = 250.00

      fywe1 = 694.45

      fywe2 = 694.45

      fce = 33.00

    From ((5.A5), TBDY), TBDY: cc = 0.00227274

      c = confinement factor = 1.02727

y1 = 0.00140044

sh1 = 0.0044814

ft1 = 466.8167

fy1 = 389.0139

su1 = 0.00512

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

  and also multiplied by the shear_factor according to 15.7.1.4, with

  Shear_factor = 1.00

  lo/lou,min = lb/ld = 0.30

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

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

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

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

  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.

  with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139

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

y2 = 0.00140044

sh2 = 0.0044814

ft2 = 466.8167

fy2 = 389.0139

su2 = 0.00512

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

  and also multiplied by the shear_factor according to 15.7.1.4, with

  Shear_factor = 1.00

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

  su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

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

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

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

  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.

  with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139

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

yv = 0.00140044

shv = 0.0044814

ftv = 466.8167

fyv = 389.0139

suv = 0.00512

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

  and also multiplied by the shear_factor according to 15.7.1.4, with

  Shear_factor = 1.00

  lo/lou,min = lb/ld = 0.30

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
 y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
 with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
 with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09172662
2 = Asl,com/(b*d)*(fs2/fc) = 0.05703813
v = Asl,mid/(b*d)*(fsv/fc) = 0.0991765
and confined core properties:
 b = 390.00
 d = 677.00
 d' = 13.00
 fcc (5A.2, TBDY) = 33.90003
  cc (5A.5, TBDY) = 0.00227274
    c = confinement factor = 1.02727
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11052844
2 = Asl,com/(b*d)*(fs2/fc) = 0.06872961
v = Asl,mid/(b*d)*(fsv/fc) = 0.11950537
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.21649239
Mu = MRc (4.14) = 9.4947E+008
 u =   su (4.1) = 9.2428803E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.4223E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.4223E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 1.4223E+006
  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 = 33.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
    Mu = 1533.833
    Vu = 2.5087409E-020
  d = 0.8*h = 600.00
  Nu = 20792.022
  Ag = 337500.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 936062.473
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 837764.743
  Vs,j1 = 523602.964 is calculated for section web jacket, with:
    d = 600.00
    Av = 157079.633
    fy = 555.56
    s = 100.00
  Vs,j1 is multiplied by   Col,j1 = 1.00
    s/d = 0.16666667

Vs,j2 = 314161.779 is calculated for section flange jacket, with:
    d = 360.00
    Av = 157079.633
    fy = 555.56
    s = 100.00
  Vs,j2 is multiplied by   Col,j2 = 1.00
    s/d = 0.27777778
 Vs,core = Vs,c1 + Vs,c2 = 98297.73
  Vs,c1 = 98297.73 is calculated for section web core, with:
    d = 440.00
    Av = 100530.965
    fy = 555.56
    s = 250.00
  Vs,c1 is multiplied by   Col,c1 = 1.00
    s/d = 0.56818182
  Vs,c2 = 0.00 is calculated for section flange core, with:
    d = 200.00
    Av = 100530.965
    fy = 555.56
    s = 250.00
  Vs,c2 is multiplied by   Col,c2 = 0.00
    s/d = 1.25
 Vf ((11-3)-(11.4), ACI 440) = 463792.00
    f = 0.95, for fully-wrapped sections
  wf/sf = 1 (FRP strips adjacent to one another).
 In (11.3) sin + cos is replaced with (cot +cota)sina which is more a generalised expression,
 where   is the angle of the crack direction (see KANEPE).
 This later relation, considered as a function Vf(,), is implemented for every different fiber orientation ai,
 as well as for 2 crack directions, =45° and =-45° to take into consideration the cyclic seismic loading.
 orientation 1:   1 = b1 + 90° = 90.00
 Vf = Min(|Vf(45, 1)|,|Vf(-45,a1)|), with:
 total thickness per orientation, tf1 = NL*t/NoDir = 1.00
 dfv = d (figure 11.2, ACI 440) = 707.00
 ffe ((11-5), ACI 440) = 328.00
    Ef = 82000.00
     fe = 0.004, from (11.6a), ACI 440
       with fu = 0.009
  From (11-11), ACI 440: Vs + Vf <= 1.0304E+006
    bw = 450.00

Calculation of Shear Strength at edge 2, Vr2 = 1.4223E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 1.4223E+006
  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 = 33.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
    Mu = 1533.833
    Vu = 2.5087409E-020
  d = 0.8*h = 600.00
  Nu = 20792.022
  Ag = 337500.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 936062.473
  where:
 Vs,jacket = Vs,j1 + Vs,j2 = 837764.743
  Vs,j1 = 523602.964 is calculated for section web jacket, with:
    d = 600.00
    Av = 157079.633
    fy = 555.56
    s = 100.00
  Vs,j1 is multiplied by   Col,j1 = 1.00

s/d = 0.16666667
Vs,j2 = 314161.779 is calculated for section flange jacket, with:
  d = 360.00
  Av = 157079.633
  fy = 555.56
  s = 100.00
Vs,j2 is multiplied by   Col,j2 = 1.00
  s/d = 0.27777778
Vs,core = Vs,c1 + Vs,c2 = 98297.73
  Vs,c1 = 98297.73 is calculated for section web core, with:
    d = 440.00
    Av = 100530.965
    fy = 555.56
    s = 250.00
  Vs,c1 is multiplied by   Col,c1 = 1.00
    s/d = 0.56818182
  Vs,c2 = 0.00 is calculated for section flange core, with:
    d = 200.00
    Av = 100530.965
    fy = 555.56
    s = 250.00
  Vs,c2 is multiplied by   Col,c2 = 0.00
    s/d = 1.25
  Vf ((11-3)-(11.4), ACI 440) = 463792.00
    f = 0.95, for fully-wrapped sections
  wf/sf = 1 (FRP strips adjacent to one another).
  In (11.3) sin + cos is replaced with (cot +cota)sina which is more a generalised expression,
  where   is the angle of the crack direction (see KANEPE).
  This later relation, considered as a function Vf(,), is implemented for every different fiber orientation ai,
  as well as for 2 crack directions, = 45° and = -45° to take into consideration the cyclic seismic loading.
  orientation 1:   1 = b1 + 90° = 90.00
  Vf = Min(|Vf(45, 1)|,|Vf(-45,a1)|), with:
  total thickness per orientation, tf1 = NL*t/NoDir = 1.00
  dfv = d (figure 11.2, ACI 440) = 707.00
  ffe ((11-5), ACI 440) = 328.00
    Ef = 82000.00
     fe = 0.004, from (11.6a), ACI 440
       with fu = 0.009
  From (11-11), ACI 440: Vs + Vf <= 1.0304E+006
    bw = 450.00

End Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjtcs

Constant Properties

Knowledge Factor,   = 0.80
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444

232

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 = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
##
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.02727
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = 5.4210109E-020
EDGE -B-
Shear Force, Vb = -5.4210109E-020
BOTH EDGES
Axial Force, F = -20792.022
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
   -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 1539.38
   -Compression: Asl,com = 1539.38
      -Middle: Asl,mid = 3612.832

Calculation of Shear Capacity ratio , Ve/Vr = 0.3589236
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 646212.952
with
Mpr1 = Max(Mu1+ , Mu1-) = 9.6932E+008
   Mu1+ = 9.6932E+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- = 9.6932E+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-) = 9.6932E+008

233

Mu2+ = 9.6932E+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- = 9.6932E+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 = 6.9132751E-006
Mu = 9.6932E+008
----
with full section properties:
 b = 450.00
 d = 907.00
 d' = 43.00
 v = 0.0015437
   N = 20792.022
 fc = 33.00
  εco (5A.5, TBDY) = 0.002
 Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.0116768
   The Shear_factor is considered equal to 1 (pure moment strength)
   From (5.4b), TBDY: εcu = 0.0116768
     ωwe ((5.4c), TBDY) = αse*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.04178759
   where ωf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

     ωfx = 0.02973616
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
       bmax = 950.00
       hmax = 750.00
       From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
         bw = 450.00
       effective stress from (A.35), ff,e = 773.4788

     ωfy = 0.02973616
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
       bmax = 950.00
       hmax = 750.00
       From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
         bw = 450.00
       effective stress from (A.35), ff,e = 773.4788

       R = 40.00
       Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
       fu,f = 840.00
       Ef = 82000.00
        εu,f = 0.015
       αse ((5.4d), TBDY) = (αse1*Aext+αse2*Aint)/Asec = 0.53375773
         αse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
         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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773

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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00227274
c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered

characteristic value f_{sy2} = $f_{s2}/1.2$, from 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 f_{s2} = ($f_{s,jacket}*A_{sl,com,jacket}$ + $f_{s,core}*A_{sl,com,core}$)/$A_{sl,com}$ = 389.0139
  with E_{s2} = ($E_{s,jacket}*A_{sl,com,jacket}$ + $E_{s,core}*A_{sl,com,core}$)/$A_{sl,com}$ = 200000.00
 y_v = 0.00140044
 sh_v = 0.0044814
ft_v = 466.8167
fy_v = 389.0139
 su_v = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
   su_v = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esuv_nominal = 0.08,
  considering characteristic value f_{syv} = $f_{sv}/1.2$, from table 5.1, TBDY
  For calculation of esuv_nominal and y_v, sh_v,ft_v,fy_v, it is considered
  characteristic value f_{syv} = $f_{sv}/1.2$, from 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 f_{sv} = ($f_{s,jacket}*A_{sl,mid,jacket}$ + $f_{s,mid}*A_{sl,mid,core}$)/$A_{sl,mid}$ = 389.0139
  with E_{sv} = ($E_{s,jacket}*A_{sl,mid,jacket}$ + $E_{s,mid}*A_{sl,mid,core}$)/$A_{sl,mid}$ = 200000.00
 1 = $A_{sl,ten}/(b*d)*(f_{s1}/f_c)$ = 0.04446081
 2 = $A_{sl,com}/(b*d)*(f_{s2}/f_c)$ = 0.04446081
 v = $A_{sl,mid}/(b*d)*(f_{sv}/f_c)$ = 0.1043468
and confined core properties:
 b = 390.00
 d = 877.00
 d' = 13.00
 fcc (5A.2, TBDY) = 33.90003
  cc (5A.5, TBDY) = 0.00227274
   c = confinement factor = 1.02727
  1 = $A_{sl,ten}/(b*d)*(f_{s1}/f_c)$ = 0.05305581
  2 = $A_{sl,com}/(b*d)*(f_{s2}/f_c)$ = 0.05305581
  v = $A_{sl,mid}/(b*d)*(f_{sv}/f_c)$ = 0.12451875
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.18345742
Mu = MRc (4.14) = 9.6932E+008
 u = su (4.1) = 6.9132751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 u = 6.9132751E-006
Mu = 9.6932E+008
----
with full section properties:
 b = 450.00
 d = 907.00
 d' = 43.00
 v = 0.0015437
  N = 20792.022
 fc = 33.00
  co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768

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

From (5.4b), TBDY: cu = 0.0116768

  we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx,   fy) = 0.04178759

where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

----

  fx = 0.02973616

Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)

af = 0.28545185

with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667

  bmax = 950.00

  hmax = 750.00

  From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444

    bw = 450.00

  effective stress from (A.35), ff,e = 773.4788

----

  fy = 0.02973616

Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)

af = 0.28545185

with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667

  bmax = 950.00

  hmax = 750.00

  From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444

    bw = 450.00

  effective stress from (A.35), ff,e = 773.4788

  R = 40.00

  Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00

  fu,f = 840.00

  Ef = 82000.00

   u,f = 0.015

  ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773

    ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773

    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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773

    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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363

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 = 2.48363

  psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593

    Lstir1 (Length of stirrups along Y) = 2160.00

    Astir1 (stirrups area) = 78.53982

  psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047

    Lstir2 (Length of stirrups along Y) = 1568.00

    Astir2 (stirrups area) = 50.26548

```
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
           Lstir1 (Length of stirrups along X) = 2560.00
           Astir1 (stirrups area) = 78.53982
        psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
           Lstir2 (Length of stirrups along X) = 1968.00
           Astir2 (stirrups area) = 50.26548
    -----------------------------------------------------------------
           Asec = 562500.00
           s1 = 100.00
           s2 = 250.00
          fywe1 = 694.45
          fywe2 = 694.45
          fce  = 33.00
     From ((5.A5), TBDY), TBDY:  cc = 0.00227274
          c = confinement factor = 1.02727
   y1 = 0.00140044
   sh1 = 0.0044814
 ft1 = 466.8167
 fy1 = 389.0139
  su1 = 0.00512
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/ld = 0.30
      su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esu1_nominal = 0.08,
     For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
     characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
      with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
      with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
   y2 = 0.00140044
   sh2 = 0.0044814
 ft2 = 466.8167
 fy2 = 389.0139
  su2 = 0.00512
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/lb,min = 0.30
      su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esu2_nominal = 0.08,
     For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
     characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
      with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
      with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
   yv = 0.00140044
   shv = 0.0044814
 ftv = 466.8167
 fyv = 389.0139
  suv = 0.00512
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/ld = 0.30
      suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esuv_nominal = 0.08,
     considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
     For calculation of esuv_nominal and  yv, shv,ftv,fyv, it is considered
     characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
      with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
      with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.04446081
   2 = Asl,com/(b*d)*(fs2/fc) = 0.04446081
```

ν = Asl,mid/(b*d)*(fsv/fc) = 0.1043468
and confined core properties:
  b = 390.00
  d = 877.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.90003
    εcc (5A.5, TBDY) = 0.00227274
      c = confinement factor = 1.02727
    ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.05305581
    ω2 = Asl,com/(b*d)*(fs2/fc) = 0.05305581
    ων = Asl,mid/(b*d)*(fsv/fc) = 0.12451875
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
ν < νs,y2 - LHS eq.(4.5) is satisfied
--->
 εsu (4.9) = 0.18345742
Mu = MRc (4.14) = 9.6932E+008
  φu = φsu (4.1) = 6.9132751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 6.9132751E-006
Mu = 9.6932E+008
----
with full section properties:
  b = 450.00
  d = 907.00
  d' = 43.00
  ν = 0.0015437
    N = 20792.022
  fc = 33.00
    εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.0116768
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.0116768
      ωwe ((5.4c), TBDY) = αse* ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.04178759
    where ωf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

      ωfx = 0.02973616
    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
    αf = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788

      ωfy = 0.02973616
    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
    αf = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00444444
        bw = 450.00

effective stress from (A.35), ff,e = 773.4788

R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
fu,f = 840.00
Ef = 82000.00
 u,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
   ase1 = Max((((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
   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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
   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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
   Lstir1 (Length of stirrups along Y) = 2160.00
   Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
   Lstir2 (Length of stirrups along Y) = 1568.00
   Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
   Lstir1 (Length of stirrups along X) = 2560.00
   Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
   Lstir2 (Length of stirrups along X) = 1968.00
   Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00227274
c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04446081
2 = Asl,com/(b*d)*(fs2/fc) = 0.04446081
v = Asl,mid/(b*d)*(fsv/fc) = 0.1043468
and confined core properties:
b = 390.00
d = 877.00
d' = 13.00
fcc (5A.2, TBDY) = 33.90003
cc (5A.5, TBDY) = 0.00227274
c = confinement factor = 1.02727
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05305581
2 = Asl,com/(b*d)*(fs2/fc) = 0.05305581
v = Asl,mid/(b*d)*(fsv/fc) = 0.12451875
Case/Assumption: Unconfinesd full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.18345742
Mu = MRc (4.14) = 9.6932E+008
u = su (4.1) = 6.9132751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 6.9132751E-006
Mu = 9.6932E+008
----
with full section properties:
  b = 450.00
  d = 907.00
  d' = 43.00
  ν = 0.0015437
     N = 20792.022
  fc = 33.00
   εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.0116768
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: εcu = 0.0116768
       we ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ρfx, ρfy) = 0.04178759
     where ρf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

       ρfx = 0.02973616
     Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
     αf = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
        bmax = 950.00
        hmax = 750.00
        From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00444444
          bw = 450.00
        effective stress from (A.35), ff,e = 773.4788

       ρfy = 0.02973616
     Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
     αf = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
        bmax = 950.00
        hmax = 750.00
        From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00444444
          bw = 450.00
        effective stress from (A.35), ff,e = 773.4788

       R = 40.00
       Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
       fu,f = 840.00
       Ef = 82000.00
        εu,f = 0.015
       ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
          ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
          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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
          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 = 252164.00 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 = 111441.00 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 = 110709.333 is the unconfined internal core area which is equal to $b_{i2}/6$ as defined at (A.2).

psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.48363

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 = 2.48363

psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593

Lstir1 (Length of stirrups along Y) = 2160.00

Astir1 (stirrups area) = 78.53982

psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047

Lstir2 (Length of stirrups along Y) = 1568.00

Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078

psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443

Lstir1 (Length of stirrups along X) = 2560.00

Astir1 (stirrups area) = 78.53982

psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345

Lstir2 (Length of stirrups along X) = 1968.00

Astir2 (stirrups area) = 50.26548

Asec = 562500.00

s1 = 100.00

s2 = 250.00

fywe1 = 694.45

fywe2 = 694.45

fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00227274

c = confinement factor = 1.02727

y1 = 0.00140044

sh1 = 0.0044814

ft1 = 466.8167

fy1 = 389.0139

su1 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/ld = 0.30

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

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

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139

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

y2 = 0.00140044

sh2 = 0.0044814

ft2 = 466.8167

fy2 = 389.0139

su2 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

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

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

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

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04446081
2 = Asl,com/(b*d)*(fs2/fc) = 0.04446081
v = Asl,mid/(b*d)*(fsv/fc) = 0.1043468
and confined core properties:
b = 390.00
d = 877.00
d' = 13.00
fcc (5A.2, TBDY) = 33.90003
cc (5A.5, TBDY) = 0.00227274
c = confinement factor = 1.02727
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05305581
2 = Asl,com/(b*d)*(fs2/fc) = 0.05305581
v = Asl,mid/(b*d)*(fsv/fc) = 0.12451875
Case/Assumption: Unconfinesd full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.18345742
Mu = MRc (4.14) = 9.6932E+008
u = su (4.1) = 6.9132751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.8004E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.8004E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 1.8004E+006
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 = 33.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.22911
Vu = 5.4210109E-020
d = 0.8*h = 760.00
Nu = 20792.022

Ag = 427500.00
From (11.5.4.8), ACI 318-14: $Vs = Vs,jacket + Vs,core = 1.1114E+006$
where:
Vs,jacket = Vs,j1 + Vs,j2 = 977392.20
Vs,j1 = 314161.779 is calculated for section web jacket, with:
  d = 360.00
  Av = 157079.633
  fy = 555.56
  s = 100.00
Vs,j1 is multiplied by Col,j1 = 1.00
  s/d = 0.27777778
Vs,j2 = 663230.422 is calculated for section flange jacket, with:
  d = 760.00
  Av = 157079.633
  fy = 555.56
  s = 100.00
Vs,j2 is multiplied by Col,j2 = 1.00
  s/d = 0.13157895
Vs,core = Vs,c1 + Vs,c2 = 134042.359
Vs,c1 = 0.00 is calculated for section web core, with:
  d = 200.00
  Av = 100530.965
  fy = 555.56
  s = 250.00
Vs,c1 is multiplied by Col,c1 = 0.00
  s/d = 1.25
Vs,c2 = 134042.359 is calculated for section flange core, with:
  d = 600.00
  Av = 100530.965
  fy = 555.56
  s = 250.00
Vs,c2 is multiplied by Col,c2 = 1.00
  s/d = 0.41666667
Vf ((11-3)-(11.4), ACI 440) = 594992.00
  ϕf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) $\sin\alpha + \cos\alpha$ is replaced with $(\cot\theta + \cot\alpha)\sin\alpha$ which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ, α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, $\theta = 45°$ and $\theta = -45°$ to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45, α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.00
dfv = d (figure 11.2, ACI 440) = 907.00
ffe ((11-5), ACI 440) = 328.00
  Ef = 82000.00
  εfe = 0.004, from (11.6a), ACI 440
    with εfu = 0.009
From (11-11), ACI 440: Vs + Vf <= 1.3051E+006
  bw = 450.00

Calculation of Shear Strength at edge 2, Vr2 = 1.8004E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
 VCol0 = 1.8004E+006
 knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ ϕf*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 = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
  Mu = 1.22911
  Vu = 5.4210109E-020
d = 0.8*h = 760.00

Nu = 20792.022
Ag = 427500.00
From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 1.1114E+006
where:
Vs,jacket = Vs,j1 + Vs,j2 = 977392.20
Vs,j1 = 314161.779 is calculated for section web jacket, with:
  d = 360.00
  Av = 157079.633
  fy = 555.56
  s = 100.00
Vs,j1 is multiplied by   Col,j1 = 1.00
  s/d = 0.27777778
Vs,j2 = 663230.422 is calculated for section flange jacket, with:
  d = 760.00
  Av = 157079.633
  fy = 555.56
  s = 100.00
Vs,j2 is multiplied by   Col,j2 = 1.00
  s/d = 0.13157895
Vs,core = Vs,c1 + Vs,c2 = 134042.359
Vs,c1 = 0.00 is calculated for section web core, with:
  d = 200.00
  Av = 100530.965
  fy = 555.56
  s = 250.00
Vs,c1 is multiplied by   Col,c1 = 0.00
  s/d = 1.25
Vs,c2 = 134042.359 is calculated for section flange core, with:
  d = 600.00
  Av = 100530.965
  fy = 555.56
  s = 250.00
Vs,c2 is multiplied by   Col,c2 = 1.00
  s/d = 0.41666667
Vf ((11-3)-(11.4), ACI 440) = 594992.00
  ϕf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sin α + cos α is replaced with (cot θ +cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ, α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ =45° and θ =-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45, α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.00
dfv = d (figure 11.2, ACI 440) = 907.00
ffe ((11-5), ACI 440) = 328.00
  Ef = 82000.00
   ϵfe = 0.004, from (11.6a), ACI 440
    with ϵfu = 0.009
From (11-11), ACI 440: Vs + Vf <= 1.3051E+006
  bw = 450.00

End Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column JTC1 of floor 1
At local axis: 2
Integration Section: (b)
Section Type: rcjtcs

Constant Properties

Knowledge Factor, γ = 0.80

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 Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lb/ld = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

Stepwise Properties

Bending Moment, M = -110881.122
Shear Force, V2 = 7990.756
Shear Force, V3 = -106.4259
Axial Force, F = -21691.294
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1539.38
     -Compression: Asl,com = 2475.575
        -Middle: Asl,mid = 2676.637
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,jacket = 1231.504
     -Compression: Asl,com,jacket = 1859.823
        -Middle: Asl,mid,jacket = 2060.885
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,core = 307.8761
     -Compression: Asl,com,core = 615.7522
        -Middle: Asl,mid,core = 615.7522
Mean Diameter of Tension Reinforcement, DbL = 16.57143

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity   u,R = 1.0* u = 0.03092838

u =   y +   p = 0.03092838

 - Calculation of   y -
----
 y = (My*Ls/3)/EIeff = 0.00092838 ((4.29),Biskinis Phd))
  My = 4.9054E+008
  Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1041.862
  From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.8350E+014
     factor = 0.30
        Ag = 562500.00
        Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
        N = 21691.294
     Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 6.1166E+014

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 = 950.00
web width, bw = 450.00
flange thickness, t = 450.00
----
  y = Min(y_ten, y_com)
  y_ten = 2.7530492E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 311.2112
    d = 707.00
     y = 0.20054914
    A = 0.01006669
    B = 0.00473366
     with pt = 0.00229194
        pc = 0.00368581
        pv = 0.00398517
        N = 21691.294
        b = 950.00
         " = 0.06082037
  y_comp = 1.5813155E-005
 with fc* (12.3, (ACI 440)) = 33.31981
    fc = 33.00
    fl = 0.5419822
    b = bmax = 950.00
    h = hmax = 750.00
    Ag = 0.5625
       g = pt + pc + pv = 0.00996292
    rc = 40.00
    Ae/Ac = 0.30198841
    Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
   effective strain from (12.5) and (12.12), efe = 0.004
    fu = 0.009
   Ef = 82000.00
   Ec = 26999.444
    y = 0.19869284
   A = 0.00989022
   B = 0.00462988
    with Es = 200000.00
CONFIRMATION: y = 0.19956371 < t/d

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

- Calculation of p -

From table 10-8: p = 0.03

with:

- Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1

  shear control ratio VyE/VCol0E = 0.44505685

  d = d_external = 707.00

  s = s_external = 0.00

- t = s1 + s2 + 2*tf/bw*(ffe/fs) = 0.00620038

 jacket: s1 = Av1*Lstir1/(s1*Ag) = 0.00301593

     Av1 = 78.53982, is the area of every stirrup parallel to loading (shear) direction

     Lstir1 = 2160.00, is the total Length of all stirrups parallel to loading (shear) direction

     s1 = 100.00

 core: s2 = Av2*Lstir2/(s2*Ag) = 0.00056047

     Av2 = 50.26548, is the area of every stirrup parallel to loading (shear) direction

     Lstir2 = 1568.00, 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 = 21691.294

  Ag = 562500.00

  f'cE = (fc_jacket*Area_jacket+ fc_core*Area_core)/section_area = 33.00

  fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+ fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein = 555.56

  fytE = (fy_ext_Trans_Reinf* s1+fy_int_Trans_Reinf* s2)/(s1+ s2) = 555.56

pl = Area_Tot_Long_Rein/(b*d) = 0.00996292

  b = 950.00

  d = 707.00

  f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column JTC1 of floor 1

At local axis: 2

Integration Section: (b)

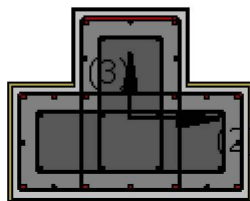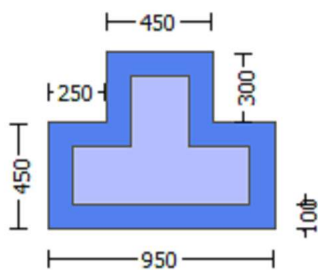
Calculation No. 15

column C1, Floor 1

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

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (3)

Start Of Calculation of Shear Capacity for element: column JTC1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rcjtcs

Constant Properties

Knowledge Factor,   = 0.80
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 Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Primary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Primary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
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 = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
##
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min =lb/ld = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00

Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

Stepwise Properties

EDGE -A-
Bending Moment, Ma = -207441.237
Shear Force, Va = 106.4259
EDGE -B-
Bending Moment, Mb = -110881.122
Shear Force, Vb = -106.4259
BOTH EDGES
Axial Force, F = -21691.294
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1539.38
      -Compression: Asl,com = 2475.575
          -Middle: Asl,mid = 2676.637
Mean Diameter of Tension Reinforcement, DbL,ten = 16.57143

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 1.2386E+006
Vn ((10.3), ASCE 41-17) = knl*VColO = 1.2386E+006
  VCol = 1.2386E+006
  knl = 1.00
     displacement_ductility_demand = 4.4319118E-007

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 = 2.00
     Mu = 110881.122
     Vu = 106.4259
  d = 0.8*h = 600.00
  Nu = 21691.294
  Ag = 337500.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 842449.486
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 753982.237
  Vs,j1 = 471238.898 is calculated for section web jacket, with:
     d = 600.00
     Av = 157079.633
     fy = 500.00
     s = 100.00
  Vs,j1 is multiplied by Col,j1 = 1.00
     s/d = 0.16666667
  Vs,j2 = 282743.339 is calculated for section flange jacket, with:
     d = 360.00
     Av = 157079.633
     fy = 500.00
     s = 100.00
  Vs,j2 is multiplied by Col,j2 = 1.00
     s/d = 0.27777778
  Vs,core = Vs,c1 + Vs,c2 = 88467.249
  Vs,c1 = 88467.249 is calculated for section web core, with:
     d = 440.00

Av = 100530.965
       fy = 500.00
       s = 250.00
    Vs,c1 is multiplied by   Col,c1 = 1.00
       s/d = 0.56818182
    Vs,c2 = 0.00 is calculated for section flange core, with:
       d = 200.00
       Av = 100530.965
       fy = 500.00
       s = 250.00
    Vs,c2 is multiplied by   Col,c2 = 0.00
       s/d = 1.25
    Vf ((11-3)-(11.4), ACI 440) = 463792.00
       f = 0.95, for fully-wrapped sections
    wf/sf = 1 (FRP strips adjacent to one another).
    In (11.3) sin + cos is replaced with (cot +cota)sina which is more a generalised expression,
    where   is the angle of the crack direction (see KANEPE).
    This later relation, considered as a function Vf(,), is implemented for every different fiber orientation ai,
    as well as for 2 crack directions, =45° and =-45° to take into consideration the cyclic seismic loading.
    orientation 1:   1 = b1 + 90° = 90.00
    Vf = Min(|Vf(45, 1)|,|Vf(-45,a1)|), with:
    total thickness per orientation, tf1 = NL*t/NoDir = 1.00
    dfv = d (figure 11.2, ACI 440) = 707.00
    ffe ((11-5), ACI 440) = 328.00
       Ef = 82000.00
        fe = 0.004, from (11.6a), ACI 440
          with fu = 0.009
     From (11-11), ACI 440: Vs + Vf <= 896810.169
       bw = 450.00

----
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   = 4.1145155E-010
  y = (My*Ls/3)/EIeff = 0.00092838 ((4.29),Biskinis Phd))
  My = 4.9054E+008
  Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1041.862
  From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.8350E+014
     factor = 0.30
        Ag = 562500.00
        Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
        N = 21691.294
     Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 6.1166E+014

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 = 950.00
web width, bw = 450.00
flange thickness, t = 450.00
----
  y = Min(y_ten, y_com)
  y_ten = 2.7530492E-006
  with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 311.2112
     d = 707.00
      y = 0.20054914
     A = 0.01006669
     B = 0.00473366
      with pt = 0.00229194

```
        pc = 0.00368581
        pv = 0.00398517
        N = 21691.294
        b = 950.00
         " = 0.06082037
  y_comp = 1.5813155E-005
 with fc* (12.3, (ACI 440)) = 33.31981
     fc = 33.00
     fl = 0.5419822
     b = bmax = 950.00
     h = hmax = 750.00
     Ag = 0.5625
        g = pt + pc + pv = 0.00996292
       rc = 40.00
       Ae/Ac = 0.30198841
       Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
     effective strain from (12.5) and (12.12), efe = 0.004
      fu = 0.009
     Ef = 82000.00
    Ec = 26999.444
     y = 0.19869284
    A = 0.00989022
    B = 0.00462988
     with Es = 200000.00
CONFIRMATION:   y = 0.19956371 < t/d
-----------------------------------------------------------
-----------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
-----------------------------------------------------------
End Of Calculation of Shear Capacity for element: column JTC1 of floor 1
At local axis: 3
Integration Section: (b)


-----------------------------------------------------------
```
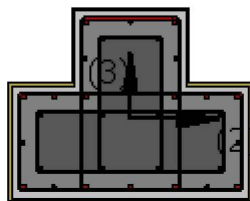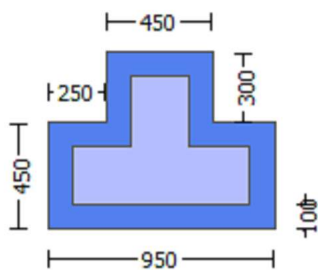
Calculation No. 16

column C1, Floor 1

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

Analysis: Uniform +X

Check: Chord rotation capacity (u)

Edge: End

Local Axis: (3)

Start Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcjtcs

Constant Properties

Knowledge Factor,   = 0.80
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
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 = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
##
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.02727
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°

Number of layers, NL = 1
Radius of rounding corners, R = 40.00

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, Va = -2.5087409E-020
EDGE -B-
Shear Force, Vb = 2.5087409E-020
BOTH EDGES
Axial Force, F = -20792.022
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1539.38
      -Compression: Asl,com = 2475.575
        -Middle: Asl,mid = 2676.637

Calculation of Shear Capacity ratio , Ve/Vr = 0.44505685
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 632982.444
with
Mpr1 = Max(Mu1+ , Mu1-) = 9.4947E+008
   Mu1+ = 6.7087E+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- = 9.4947E+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-) = 9.4947E+008
   Mu2+ = 6.7087E+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- = 9.4947E+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 = 8.5351751E-006
Mu = 6.7087E+008
----
with full section properties:
   b = 950.00
   d = 707.00
   d' = 43.00
   v = 0.00093808
      N = 20792.022
   fc = 33.00
    co (5A.5, TBDY) = 0.002
   Final value of   cu: cu* = shear_factor * Max(cu, cc) = 0.0116768
      The Shear_factor is considered equal to 1 (pure moment strength)
      From (5.4b), TBDY: cu = 0.0116768
        we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx,   fy) = 0.04178759
      where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
      ----
        fx = 0.02973616
      Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
      af = 0.28545185
      with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
        bmax = 950.00

hmax = 750.00
From EC8 A 4.4.3(6), pf = 2tf/bw = 0.00444444
   bw = 450.00
effective stress from (A.35), ff,e = 773.4788

----

fy = 0.02973616
Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
af = 0.28545185
with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
   bmax = 950.00
   hmax = 750.00
   From EC8 A 4.4.3(6), pf = 2tf/bw = 0.00444444
      bw = 450.00
   effective stress from (A.35), ff,e = 773.4788

R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
fu,f = 840.00
Ef = 82000.00
 u,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
   ase1 = Max((((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
   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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
   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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
   Lstir1 (Length of stirrups along Y) = 2160.00
   Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
   Lstir2 (Length of stirrups along Y) = 1568.00
   Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
   Lstir1 (Length of stirrups along X) = 2560.00
   Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
   Lstir2 (Length of stirrups along X) = 1968.00
   Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00

```
          s2 = 250.00
        fywe1 = 694.45
        fywe2 = 694.45
         fce = 33.00
    From ((5.A5), TBDY), TBDY:  cc = 0.00227274
         c = confinement factor = 1.02727
   y1 = 0.00140044
  sh1 = 0.0044814
 ft1 = 466.8167
 fy1 = 389.0139
  su1 = 0.00512
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/ld = 0.30
      su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esu1_nominal = 0.08,
     For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
     characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
      with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
      with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
   y2 = 0.00140044
  sh2 = 0.0044814
 ft2 = 466.8167
 fy2 = 389.0139
  su2 = 0.00512
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/lb,min = 0.30
      su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esu2_nominal = 0.08,
     For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
     characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
      with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
      with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
   yv = 0.00140044
  shv = 0.0044814
 ftv = 466.8167
 fyv = 389.0139
  suv = 0.00512
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/ld = 0.30
      suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esuv_nominal = 0.08,
     considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
     For calculation of esuv_nominal and  yv, shv,ftv,fyv, it is considered
     characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
      with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
      with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.02701806
    2 = Asl,com/(b*d)*(fs2/fc) = 0.04344945
    v = Asl,mid/(b*d)*(fsv/fc) = 0.04697834
 and confined core properties:
   b = 890.00
   d = 677.00
   d' = 13.00
   fcc (5A.2, TBDY) = 33.90003
    cc (5A.5, TBDY) = 0.00227274
       c = confinement factor = 1.02727
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.03011747
    2 = Asl,com/(b*d)*(fs2/fc) = 0.04843381
```

```
    v = Asl,mid/(b*d)*(fsv/fc) = 0.05236752
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.15152684
Mu = MRc (4.14) = 6.7087E+008
 u =    su (4.1) = 8.5351751E-006
---------------------------------------------------------------

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

----------------------------------------------------------------------------
Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 9.2428803E-006
Mu = 9.4947E+008
----------------------------------------------------------------------------
with full section properties:
  b = 450.00
  d = 707.00
  d' = 43.00
  v = 0.00198039
    N = 20792.022
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of  cu:  cu* = shear_factor * Max( cu,  cc) = 0.0116768
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY:  cu = 0.0116768
       we ((5.4c), TBDY) = ase*  sh,min*fywe/fce+Min(  fx,   fy) = 0.04178759
     where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
     ----------------------------------------------------------------------
       fx = 0.02973616
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
        bmax = 950.00
        hmax = 750.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
          bw = 450.00
        effective stress from (A.35), ff,e = 773.4788
     ----------------------------------------------------------------
       fy = 0.02973616
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
        bmax = 950.00
        hmax = 750.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
          bw = 450.00
        effective stress from (A.35), ff,e = 773.4788
     ----------------------------------------------------------------
        R = 40.00
        Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
        fu,f = 840.00
        Ef = 82000.00
         u,f = 0.015
        ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
          ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
          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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
   Lstir1 (Length of stirrups along Y) = 2160.00
   Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
   Lstir2 (Length of stirrups along Y) = 1568.00
   Astir2 (stirrups area) = 50.26548
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
   Lstir1 (Length of stirrups along X) = 2560.00
   Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
   Lstir2 (Length of stirrups along X) = 1968.00
   Astir2 (stirrups area) = 50.26548

   Asec = 562500.00
   s1 = 100.00
   s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00227274
   c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and   y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044

sh2 = 0.0044814
  ft2 = 466.8167
  fy2 = 389.0139
   su2 = 0.00512
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/lb,min = 0.30
      su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esu2_nominal = 0.08,
     For calculation of esu2_nominal and   y2, sh2,ft2,fy2, it is considered
     characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
       y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
        with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
        with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
   yv = 0.00140044
   shv = 0.0044814
  ftv = 466.8167
  fyv = 389.0139
   suv = 0.00512
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/ld = 0.30
      suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esuv_nominal = 0.08,
     considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
     For calculation of esuv_nominal and   yv, shv,ftv,fyv, it is considered
     characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
       y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
        with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
        with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.09172662
     2 = Asl,com/(b*d)*(fs2/fc) = 0.05703813
     v = Asl,mid/(b*d)*(fsv/fc) = 0.0991765
and confined core properties:
   b = 390.00
   d = 677.00
   d' = 13.00
   fcc (5A.2, TBDY) = 33.90003
    cc (5A.5, TBDY) = 0.00227274
      c = confinement factor = 1.02727
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.11052844
     2 = Asl,com/(b*d)*(fs2/fc) = 0.06872961
     v = Asl,mid/(b*d)*(fsv/fc) = 0.11950537
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.21649239
Mu = MRc (4.14) = 9.4947E+008
  u =   su (4.1) = 9.2428803E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 8.5351751E-006

Mu = 6.7087E+008

----

with full section properties:
  b = 950.00
  d = 707.00
  d' = 43.00
  v = 0.00093808
    N = 20792.022
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.0116768
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.04178759
    where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----
      fx = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788
    ----
      fy = 0.02973616
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
        bw = 450.00
      effective stress from (A.35), ff,e = 773.4788

      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
      fu,f = 840.00
      Ef = 82000.00
      u,f = 0.015
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
        ase1 = Max((((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
        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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
        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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363

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 = 2.48363
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
            Lstir1 (Length of stirrups along Y) = 2160.00
            Astir1 (stirrups area) = 78.53982
        psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
            Lstir2 (Length of stirrups along Y) = 1568.00
            Astir2 (stirrups area) = 50.26548

        ----------------------------------------------------------------
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
            Lstir1 (Length of stirrups along X) = 2560.00
            Astir1 (stirrups area) = 78.53982
        psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
            Lstir2 (Length of stirrups along X) = 1968.00
            Astir2 (stirrups area) = 50.26548

        ----------------------------------------------------------------
        Asec = 562500.00
        s1 = 100.00
        s2 = 250.00
        fywe1 = 694.45
        fywe2 = 694.45
        fce  = 33.00
    From ((5.A5), TBDY), TBDY:  cc = 0.00227274
        c = confinement factor = 1.02727
    y1 = 0.00140044
    sh1 = 0.0044814
    ft1 = 466.8167
    fy1 = 389.0139
    su1 = 0.00512
        using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
        and also multiplied by the shear_factor according to 15.7.1.4, with
        Shear_factor = 1.00
        lo/lou,min = lb/ld = 0.30
        su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
        From table 5A.1, TBDY: esu1_nominal = 0.08,
        For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
        characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
        y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
        with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
        with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
    y2 = 0.00140044
    sh2 = 0.0044814
    ft2 = 466.8167
    fy2 = 389.0139
    su2 = 0.00512
        using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
        and also multiplied by the shear_factor according to 15.7.1.4, with
        Shear_factor = 1.00
        lo/lou,min = lb/lb,min = 0.30
        su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
        From table 5A.1, TBDY: esu2_nominal = 0.08,
        For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
        characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
        y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
        with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
        with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
    yv = 0.00140044
    shv = 0.0044814
    ftv = 466.8167
    fyv = 389.0139
    suv = 0.00512
        using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
        and also multiplied by the shear_factor according to 15.7.1.4, with
        Shear_factor = 1.00
```

lo/lou,min = lb/ld = 0.30
  suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
 y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
 with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
 with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.02701806
 2 = Asl,com/(b*d)*(fs2/fc) = 0.04344945
 v = Asl,mid/(b*d)*(fsv/fc) = 0.04697834
and confined core properties:
 b = 890.00
 d = 677.00
 d' = 13.00
 fcc (5A.2, TBDY) = 33.90003
  cc (5A.5, TBDY) = 0.00227274
   c = confinement factor = 1.02727
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.03011747
  2 = Asl,com/(b*d)*(fs2/fc) = 0.04843381
  v = Asl,mid/(b*d)*(fsv/fc) = 0.05236752
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.15152684
Mu = MRc (4.14) = 6.7087E+008
 u = su (4.1) = 8.5351751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 u = 9.2428803E-006
Mu = 9.4947E+008
----
with full section properties:
 b = 450.00
 d = 707.00
 d' = 43.00
 v = 0.00198039
  N = 20792.022
 fc = 33.00
  co (5A.5, TBDY) = 0.002
 Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768
  The Shear_factor is considered equal to 1 (pure moment strength)
  From (5.4b), TBDY: cu = 0.0116768
   we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.04178759
  where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
   ----
   fx = 0.02973616
  Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
  af = 0.28545185
  with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
   bmax = 950.00
   hmax = 750.00
   From EC8 A4.4.3(6), pf = 2tf/bw = 0.00444444

bw = 450.00
effective stress from (A.35), ff,e = 773.4788
----
fy = 0.02973616
Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
af = 0.28545185
with Unconfined area = ((bmax-2R)^2+ (hmax-2R)^2)/3 = 160566.667
bmax = 950.00
hmax = 750.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00444444
bw = 450.00
effective stress from (A.35), ff,e = 773.4788

R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
fu,f = 840.00
Ef = 82000.00
u,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ ase2*Aint)/Asec = 0.53375773
ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45

fywe2 = 694.45
          fce = 33.00
      From ((5.A5), TBDY), TBDY: cc = 0.00227274
            c = confinement factor = 1.02727
    y1 = 0.00140044
    sh1 = 0.0044814
  ft1 = 466.8167
  fy1 = 389.0139
   su1 = 0.00512
      using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
      and also multiplied by the shear_factor according to 15.7.1.4, with
      Shear_factor = 1.00
      lo/lou,min = lb/ld = 0.30
       su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
      From table 5A.1, TBDY: esu1_nominal = 0.08,
      For calculation of esu1_nominal and   y1, sh1,ft1,fy1, it is considered
      characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
       y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
       with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
       with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
    y2 = 0.00140044
    sh2 = 0.0044814
  ft2 = 466.8167
  fy2 = 389.0139
   su2 = 0.00512
      using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
      and also multiplied by the shear_factor according to 15.7.1.4, with
      Shear_factor = 1.00
      lo/lou,min = lb/lb,min = 0.30
       su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
      From table 5A.1, TBDY: esu2_nominal = 0.08,
      For calculation of esu2_nominal and   y2, sh2,ft2,fy2, it is considered
      characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
       y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
       with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
       with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
    yv = 0.00140044
    shv = 0.0044814
  ftv = 466.8167
  fyv = 389.0139
   suv = 0.00512
      using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
      and also multiplied by the shear_factor according to 15.7.1.4, with
      Shear_factor = 1.00
      lo/lou,min = lb/ld = 0.30
       suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
      From table 5A.1, TBDY: esuv_nominal = 0.08,
      considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
      For calculation of esuv_nominal and   yv, shv,ftv,fyv, it is considered
      characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
       y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
       with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
       with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.09172662
    2 = Asl,com/(b*d)*(fs2/fc) = 0.05703813
    v = Asl,mid/(b*d)*(fsv/fc) = 0.0991765
and confined core properties:
   b = 390.00
   d = 677.00
   d' = 13.00
   fcc (5A.2, TBDY) = 33.90003
    cc (5A.5, TBDY) = 0.00227274
       c = confinement factor = 1.02727
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.11052844
    2 = Asl,com/(b*d)*(fs2/fc) = 0.06872961
    v = Asl,mid/(b*d)*(fsv/fc) = 0.11950537
Case/Assumption: Unconfinesd full section - Steel rupture

' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.21649239
Mu = MRc (4.14) = 9.4947E+008
 u = su (4.1) = 9.2428803E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.4223E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.4223E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 1.4223E+006
  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 = 33.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
    Mu = 1533.833
    Vu = 2.5087409E-020
  d = 0.8*h = 600.00
  Nu = 20792.022
  Ag = 337500.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 936062.473
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 837764.743
  Vs,j1 = 523602.964 is calculated for section web jacket, with:
    d = 600.00
    Av = 157079.633
    fy = 555.56
    s = 100.00
  Vs,j1 is multiplied by Col,j1 = 1.00
    s/d = 0.16666667
  Vs,j2 = 314161.779 is calculated for section flange jacket, with:
    d = 360.00
    Av = 157079.633
    fy = 555.56
    s = 100.00
  Vs,j2 is multiplied by Col,j2 = 1.00
    s/d = 0.27777778
  Vs,core = Vs,c1 + Vs,c2 = 98297.73
  Vs,c1 = 98297.73 is calculated for section web core, with:
    d = 440.00
    Av = 100530.965
    fy = 555.56
    s = 250.00
  Vs,c1 is multiplied by Col,c1 = 1.00
    s/d = 0.56818182
  Vs,c2 = 0.00 is calculated for section flange core, with:
    d = 200.00
    Av = 100530.965
    fy = 555.56
    s = 250.00
  Vs,c2 is multiplied by Col,c2 = 0.00
    s/d = 1.25

Vf ((11-3)-(11.4), ACI 440) = 463792.00
  f = 0.95, for fully-wrapped sections
 wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sin + cos is replaced with (cot +cota)sina which is more a generalised expression,
where is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(,), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, =45° and =-45° to take into consideration the cyclic seismic loading.
orientation 1: 1 = b1 + 90° = 90.00
Vf = Min(|Vf(45, 1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.00
dfv = d (figure 11.2, ACI 440) = 707.00
ffe ((11-5), ACI 440) = 328.00
  Ef = 82000.00
   fe = 0.004, from (11.6a), ACI 440
    with fu = 0.009
 From (11-11), ACI 440: Vs + Vf < = 1.0304E+006
   bw = 450.00

Calculation of Shear Strength at edge 2, Vr2 = 1.4223E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
 VCol0 = 1.4223E+006
 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 = 33.00, but fc^0.5 < = 8.3 MPa (22.5.3.1, ACI 318-14)
 M/Vd = 2.00
   Mu = 1533.833
   Vu = 2.5087409E-020
 d = 0.8*h = 600.00
 Nu = 20792.022
 Ag = 337500.00
 From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 936062.473
 where:
 Vs,jacket = Vs,j1 + Vs,j2 = 837764.743
 Vs,j1 = 523602.964 is calculated for section web jacket, with:
  d = 600.00
  Av = 157079.633
  fy = 555.56
  s = 100.00
 Vs,j1 is multiplied by Col,j1 = 1.00
  s/d = 0.16666667
 Vs,j2 = 314161.779 is calculated for section flange jacket, with:
  d = 360.00
  Av = 157079.633
  fy = 555.56
  s = 100.00
 Vs,j2 is multiplied by Col,j2 = 1.00
  s/d = 0.27777778
 Vs,core = Vs,c1 + Vs,c2 = 98297.73
 Vs,c1 = 98297.73 is calculated for section web core, with:
  d = 440.00
  Av = 100530.965
  fy = 555.56
  s = 250.00
 Vs,c1 is multiplied by Col,c1 = 1.00
  s/d = 0.56818182
 Vs,c2 = 0.00 is calculated for section flange core, with:
  d = 200.00
  Av = 100530.965
  fy = 555.56
  s = 250.00
 Vs,c2 is multiplied by Col,c2 = 0.00

s/d = 1.25
  Vf ((11-3)-(11.4), ACI 440) = 463792.00
    f = 0.95, for fully-wrapped sections
  wf/sf = 1 (FRP strips adjacent to one another).
  In (11.3) sin + cos is replaced with (cot +cota)sina which is more a generalised expression,
  where is the angle of the crack direction (see KANEPE).
  This later relation, considered as a function Vf(,), is implemented for every different fiber orientation ai,
  as well as for 2 crack directions, = 45° and = -45° to take into consideration the cyclic seismic loading.
  orientation 1: 1 = b1 + 90° = 90.00
  Vf = Min(|Vf(45, 1)|,|Vf(-45,a1)|), with:
  total thickness per orientation, tf1 = NL*t/NoDir = 1.00
  dfv = d (figure 11.2, ACI 440) = 707.00
  ffe ((11-5), ACI 440) = 328.00
    Ef = 82000.00
     fe = 0.004, from (11.6a), ACI 440
       with fu = 0.009
  From (11-11), ACI 440: Vs + Vf <= 1.0304E+006
    bw = 450.00

End Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjtcs

Constant Properties

Knowledge Factor, = 0.80
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
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 = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
###
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.02727
Element Length, L = 3000.00
Primary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, Va = 5.4210109E-020
EDGE -B-
Shear Force, Vb = -5.4210109E-020
BOTH EDGES
Axial Force, F = -20792.022
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
    -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 1539.38
    -Compression: Asl,com = 1539.38
      -Middle: Asl,mid = 3612.832

Calculation of Shear Capacity ratio , Ve/Vr = 0.3589236
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 646212.952
with
Mpr1 = Max(Mu1+ , Mu1-) = 9.6932E+008
  Mu1+ = 9.6932E+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- = 9.6932E+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-) = 9.6932E+008
  Mu2+ = 9.6932E+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- = 9.6932E+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 = 6.9132751E-006
Mu = 9.6932E+008
----
with full section properties:
  b = 450.00
  d = 907.00
  d' = 43.00
  v = 0.0015437
    N = 20792.022
  fc = 33.00
    co (5A.5, TBDY) = 0.002

Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768
  The Shear_factor is considered equal to 1 (pure moment strength)
  From (5.4b), TBDY: cu = 0.0116768
    we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx,   fy) = 0.04178759
  where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
  ----
    fx = 0.02973616
  Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
  af = 0.28545185
  with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
    bmax = 950.00
    hmax = 750.00
    From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
      bw = 450.00
    effective stress from (A.35), ff,e = 773.4788
  ----
    fy = 0.02973616
  Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
  af = 0.28545185
  with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
    bmax = 950.00
    hmax = 750.00
    From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
      bw = 450.00
    effective stress from (A.35), ff,e = 773.4788

    R = 40.00
    Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
    fu,f = 840.00
    Ef = 82000.00
     u,f = 0.015
    ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
      ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
      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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
      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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
  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 = 2.48363
    psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
      Lstir1 (Length of stirrups along Y) = 2160.00
      Astir1 (stirrups area) = 78.53982
    psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
      Lstir2 (Length of stirrups along Y) = 1568.00
      Astir2 (stirrups area) = 50.26548

```
------------------------------------------------------------------
    psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
    psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
       Lstir1 (Length of stirrups along X) = 2560.00
       Astir1 (stirrups area) = 78.53982
    psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
       Lstir2 (Length of stirrups along X) = 1968.00
       Astir2 (stirrups area) = 50.26548
------------------------------------------------------------------
       Asec = 562500.00
       s1 = 100.00
       s2 = 250.00
    fywe1 = 694.45
    fywe2 = 694.45
    fce  = 33.00
  From ((5.A5), TBDY), TBDY:  cc = 0.00227274
       c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.30
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esu1_nominal = 0.08,
   For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
   characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/lb,min = 0.30
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esu2_nominal = 0.08,
   For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
   characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.30
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esuv_nominal = 0.08,
   considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
   For calculation of esuv_nominal and  yv, shv,ftv,fyv, it is considered
   characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.04446081
```

```
       2 = Asl,com/(b*d)*(fs2/fc) = 0.04446081
       v = Asl,mid/(b*d)*(fsv/fc) = 0.1043468
and confined core properties:
   b = 390.00
   d = 877.00
   d' = 13.00
  fcc (5A.2, TBDY) = 33.90003
    cc (5A.5, TBDY) = 0.00227274
      c = confinement factor = 1.02727
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.05305581
     2 = Asl,com/(b*d)*(fs2/fc) = 0.05305581
     v = Asl,mid/(b*d)*(fsv/fc) = 0.12451875
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.18345742
Mu = MRc (4.14) = 9.6932E+008
  u =   su (4.1) = 6.9132751E-006
---------------------------------------------------------

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

------------------------------------------------------------------
Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
   u = 6.9132751E-006
Mu = 9.6932E+008
------------------------------------------------------------------
with full section properties:
   b = 450.00
   d = 907.00
   d' = 43.00
   v = 0.0015437
      N = 20792.022
   fc = 33.00
    co (5A.5, TBDY) = 0.002
   Final value of   cu:  cu* = shear_factor * Max( cu, cc) = 0.0116768
      The Shear_factor is considered equal to 1 (pure moment strength)
      From (5.4b), TBDY:  cu = 0.0116768
        we ((5.4c), TBDY) =  ase*  sh,min*fywe/fce+Min(  fx,   fy) = 0.04178759
      where   f =  af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
      ----------------------------------------------------------------
        fx = 0.02973616
      Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
      af = 0.28545185
      with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
         bmax = 950.00
         hmax = 750.00
         From EC8 A4.4.3(6), pf = 2tf/bw = 0.00444444
           bw = 450.00
         effective stress from (A.35), ff,e = 773.4788
      ----------------------------------------------------------------
        fy = 0.02973616
      Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
      af = 0.28545185
      with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
         bmax = 950.00
         hmax = 750.00
         From EC8 A4.4.3(6), pf = 2tf/bw = 0.00444444
```

bw = 450.00
effective stress from (A.35), ff,e = 773.4788

R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
fu,f = 840.00
Ef = 82000.00
 u,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
    ase1 = Max((((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
    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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
    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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
    Lstir1 (Length of stirrups along Y) = 2160.00
    Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
    Lstir2 (Length of stirrups along Y) = 1568.00
    Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
    Lstir1 (Length of stirrups along X) = 2560.00
    Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
    Lstir2 (Length of stirrups along X) = 1968.00
    Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00227274
    c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/ld = 0.30
      su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esu1_nominal = 0.08,
     For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
     characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
      with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
      with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
   y2 = 0.00140044
   sh2 = 0.0044814
  ft2 = 466.8167
  fy2 = 389.0139
   su2 = 0.00512
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/lb,min = 0.30
      su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esu2_nominal = 0.08,
     For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
     characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
      with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
      with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
   yv = 0.00140044
   shv = 0.0044814
  ftv = 466.8167
  fyv = 389.0139
   suv = 0.00512
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/ld = 0.30
      suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esuv_nominal = 0.08,
     considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
     For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
     characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
      y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
      with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
      with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.04446081
    2 = Asl,com/(b*d)*(fs2/fc) = 0.04446081
    v = Asl,mid/(b*d)*(fsv/fc) = 0.1043468
and confined core properties:
   b = 390.00
   d = 877.00
   d' = 13.00
   fcc (5A.2, TBDY) = 33.90003
    cc (5A.5, TBDY) = 0.00227274
      c = confinement factor = 1.02727
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.05305581
    2 = Asl,com/(b*d)*(fs2/fc) = 0.05305581
    v = Asl,mid/(b*d)*(fsv/fc) = 0.12451875
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.18345742
Mu = MRc (4.14) = 9.6932E+008
  u =   su (4.1) = 6.9132751E-006

Calculation of ratio lb/ld

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


--------------------------------------------------------------------------
Calculation of ultimate curvature  u according to 4.1, Biskinis/Fardis 2013:
  u = 6.9132751E-006
Mu = 9.6932E+008
--------------------------------------------------------------------------
with full section properties:
  b = 450.00
  d = 907.00
  d' = 43.00
  v = 0.0015437
    N = 20792.022
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of  cu:  cu* = shear_factor * Max( cu, cc) = 0.0116768
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY:  cu = 0.0116768
       we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min( fx,  fy) = 0.04178759
     where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
     ----------------------------------------------------------------
       fx = 0.02973616
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
        bmax = 950.00
        hmax = 750.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
           bw = 450.00
        effective stress from (A.35), ff,e = 773.4788
     ----------------------------------------------------------------
       fy = 0.02973616
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
        bmax = 950.00
        hmax = 750.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00444444
           bw = 450.00
        effective stress from (A.35), ff,e = 773.4788
     ----------------------------------------------------------------
        R = 40.00
        Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
        fu,f = 840.00
        Ef = 82000.00
         u,f = 0.015
        ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
           ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
           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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
           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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00227274
c = confinement factor = 1.02727
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
  with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
  with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
  suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esuv_nominal = 0.08,
  considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
  For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
  characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
  y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
  with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04446081
2 = Asl,com/(b*d)*(fs2/fc) = 0.04446081
v = Asl,mid/(b*d)*(fsv/fc) = 0.1043468
and confined core properties:
  b = 390.00
  d = 877.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.90003
  cc (5A.5, TBDY) = 0.00227274
    c = confinement factor = 1.02727
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.05305581
  2 = Asl,com/(b*d)*(fs2/fc) = 0.05305581
  v = Asl,mid/(b*d)*(fsv/fc) = 0.12451875
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.18345742
Mu = MRc (4.14) = 9.6932E+008
 u = su (4.1) = 6.9132751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 u = 6.9132751E-006
Mu = 9.6932E+008
----
with full section properties:
  b = 450.00
  d = 907.00
  d' = 43.00
  v = 0.0015437
    N = 20792.022
  fc = 33.00
  co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0116768
    The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: cu = 0.0116768
   we ((5.4c), TBDY) = ase* sh,min*fywe/fce+ Min(fx, fy) = 0.04178759
where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----
   fx = 0.02973616
Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
af = 0.28545185
with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
   bmax = 950.00
   hmax = 750.00
   From EC8 A4.4.3(6), pf = 2tf/bw = 0.00444444
      bw = 450.00
   effective stress from (A.35), ff,e = 773.4788
----
   fy = 0.02973616
Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
af = 0.28545185
with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
   bmax = 950.00
   hmax = 750.00
   From EC8 A4.4.3(6), pf = 2tf/bw = 0.00444444
      bw = 450.00
   effective stress from (A.35), ff,e = 773.4788

   R = 40.00
   Effective FRP thickness, tf = NL*t*Cos(b1) = 1.00
   fu,f = 840.00
   Ef = 82000.00
    u,f = 0.015
   ase ((5.4d), TBDY) = (ase1*Aext+ ase2*Aint)/Asec = 0.53375773
      ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
      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 = 464100.00 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 = 395025.00 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 = 173066.667 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) = 0.53375773
      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 = 252164.00 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 = 111441.00 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 = 110709.333 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) = 2.48363
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 = 2.48363
   psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
      Lstir1 (Length of stirrups along Y) = 2160.00
      Astir1 (stirrups area) = 78.53982
   psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
      Lstir2 (Length of stirrups along Y) = 1568.00
      Astir2 (stirrups area) = 50.26548
----
   psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.97078

```
    psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
        Lstir1 (Length of stirrups along X) = 2560.00
        Astir1 (stirrups area) = 78.53982
    psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
        Lstir2 (Length of stirrups along X) = 1968.00
        Astir2 (stirrups area) = 50.26548
 ---------------------------------------------------------------------
        Asec = 562500.00
        s1 = 100.00
        s2 = 250.00
     fywe1 = 694.45
     fywe2 = 694.45
     fce  = 33.00
   From ((5.A5), TBDY), TBDY:  cc = 0.00227274
        c  = confinement factor = 1.02727
 y1 = 0.00140044
 sh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
 su1 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.30
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esu1_nominal = 0.08,
   For calculation of esu1_nominal and  y1, sh1,ft1,fy1, it is considered
   characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 389.0139
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
 y2 = 0.00140044
 sh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
 su2 = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/lb,min = 0.30
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esu2_nominal = 0.08,
   For calculation of esu2_nominal and  y2, sh2,ft2,fy2, it is considered
   characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 389.0139
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
 yv = 0.00140044
 shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
 suv = 0.00512
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.30
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
   From table 5A.1, TBDY: esuv_nominal = 0.08,
   considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
   For calculation of esuv_nominal and  yv, shv,ftv,fyv, it is considered
   characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.04446081
 2 = Asl,com/(b*d)*(fs2/fc) = 0.04446081
 v = Asl,mid/(b*d)*(fsv/fc) = 0.1043468
```

and confined core properties:
    b = 390.00
    d = 877.00
    d' = 13.00
    fcc (5A.2, TBDY) = 33.90003
      cc (5A.5, TBDY) = 0.00227274
        c = confinement factor = 1.02727
      1 = Asl,ten/(b*d)*(fs1/fc) = 0.05305581
      2 = Asl,com/(b*d)*(fs2/fc) = 0.05305581
      v = Asl,mid/(b*d)*(fsv/fc) = 0.12451875
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
  su (4.9) = 0.18345742
Mu = MRc (4.14) = 9.6932E+008
  u =   su (4.1) = 6.9132751E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.8004E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.8004E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
   VCol0 = 1.8004E+006
   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 = 33.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
   M/Vd = 2.00
      Mu = 1.22911
      Vu = 5.4210109E-020
   d = 0.8*h = 760.00
   Nu = 20792.022
   Ag = 427500.00
   From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 1.1114E+006
   where:
   Vs,jacket = Vs,j1 + Vs,j2 = 977392.20
   Vs,j1 = 314161.779 is calculated for section web jacket, with:
      d = 360.00
      Av = 157079.633
      fy = 555.56
      s = 100.00
   Vs,j1 is multiplied by   Col,j1 = 1.00
      s/d = 0.27777778
   Vs,j2 = 663230.422 is calculated for section flange jacket, with:
      d = 760.00
      Av = 157079.633
      fy = 555.56
      s = 100.00
   Vs,j2 is multiplied by   Col,j2 = 1.00
      s/d = 0.13157895
   Vs,core = Vs,c1 + Vs,c2 = 134042.359
   Vs,c1 = 0.00 is calculated for section web core, with:
      d = 200.00
      Av = 100530.965

fy = 555.56
s = 250.00
Vs,c1 is multiplied by Col,c1 = 0.00
s/d = 1.25
Vs,c2 = 134042.359 is calculated for section flange core, with:
d = 600.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs,c2 is multiplied by Col,c2 = 1.00
s/d = 0.41666667
Vf ((11-3)-(11.4), ACI 440) = 594992.00
ϕf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sin α + cos α is replaced with (cot θ +cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ, α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α_1 = b1 + 90° = 90.00
Vf = Min(|Vf(45, α_1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.00
dfv = d (figure 11.2, ACI 440) = 907.00
ffe ((11-5), ACI 440) = 328.00
Ef = 82000.00
ϵfe = 0.004, from (11.6a), ACI 440
with ϵfu = 0.009
From (11-11), ACI 440: Vs + Vf <= 1.3051E+006
bw = 450.00

Calculation of Shear Strength at edge 2, Vr2 = 1.8004E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 1.8004E+006
knl = 1 (zero step-static loading)

NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ ϕf*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 = 33.00, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.22911
Vu = 5.4210109E-020
d = 0.8*h = 760.00
Nu = 20792.022
Ag = 427500.00
From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 1.1114E+006
where:
Vs,jacket = Vs,j1 + Vs,j2 = 977392.20
Vs,j1 = 314161.779 is calculated for section web jacket, with:
d = 360.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs,j1 is multiplied by Col,j1 = 1.00
s/d = 0.27777778
Vs,j2 = 663230.422 is calculated for section flange jacket, with:
d = 760.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs,j2 is multiplied by Col,j2 = 1.00
s/d = 0.13157895
Vs,core = Vs,c1 + Vs,c2 = 134042.359
Vs,c1 = 0.00 is calculated for section web core, with:
d = 200.00

Av = 100530.965
        fy = 555.56
        s = 250.00
    Vs,c1 is multiplied by   Col,c1 = 0.00
        s/d = 1.25
    Vs,c2 = 134042.359 is calculated for section flange core, with:
        d = 600.00
        Av = 100530.965
        fy = 555.56
        s = 250.00
    Vs,c2 is multiplied by   Col,c2 = 1.00
        s/d = 0.41666667
    Vf ((11-3)-(11.4), ACI 440) = 594992.00
        f = 0.95, for fully-wrapped sections
    wf/sf = 1 (FRP strips adjacent to one another).
    In (11.3) sin + cos is replaced with (cot +cota)sina which is more a generalised expression,
    where   is the angle of the crack direction (see KANEPE).
    This later relation, considered as a function Vf(,), is implemented for every different fiber orientation ai,
    as well as for 2 crack directions, =45° and =-45° to take into consideration the cyclic seismic loading.
    orientation 1:   1 = b1 + 90° = 90.00
    Vf = Min(|Vf(45, 1)|,|Vf(-45,a1)|), with:
    total thickness per orientation, tf1 = NL*t/NoDir = 1.00
    dfv = d (figure 11.2, ACI 440) = 907.00
    ffe ((11-5), ACI 440) = 328.00
        Ef = 82000.00
         fe = 0.004, from (11.6a), ACI 440
           with fu = 0.009
    From (11-11), ACI 440: Vs + Vf <= 1.3051E+006
        bw = 450.00

End Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column JTC1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rcjtcs

Constant Properties

Knowledge Factor,   = 0.80
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 Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Primary Member: Concrete Strength, fc = fcm = 33.00
New material of Primary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member

Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lb/ld = 0.30
FRP Wrapping Data
Type: Carbon
Dry properties (design values)
Thickness, t = 1.00
Tensile Strength, ffu = 840.00
Tensile Modulus, Ef = 82000.00
Elongation, efu = 0.009
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

Stepwise Properties

Bending Moment, M = 211408.354
Shear Force, V2 = 7990.756
Shear Force, V3 = -106.4259
Axial Force, F = -21691.294
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
    -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1539.38
     -Compression: Asl,com = 1539.38
        -Middle: Asl,mid = 3612.832
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,jacket = 1231.504
     -Compression: Asl,com,jacket = 1231.504
        -Middle: Asl,mid,jacket = 2689.203
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,core = 307.8761
     -Compression: Asl,com,core = 307.8761
        -Middle: Asl,mid,core = 923.6282
Mean Diameter of Tension Reinforcement, DbL = 16.57143

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $\theta u,R = 1.0^* \theta u = 0.03024182$
 $\theta u = \theta y + \theta p = 0.03024182$

 - Calculation of θy -

 $\theta y = (My^*Ls/3)/EIeff = 0.00024182$ ((4.29),Biskinis Phd))
  My = 6.7438E+008
  Ls = M/V (with Ls > 0.1*L and Ls < 2*L) = 300.00
  From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 2.7887E+014
    factor = 0.30
       Ag = 562500.00
       Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
       N = 21691.294
    Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 9.2958E+014

Calculation of Yielding Moment My

Calculation of θy and My according to Annex 7 -

 $\theta y = Min(\theta y\_ten, \theta y\_com)$

y_ten = 2.3115293E-006
with ((10.1), ASCE 41-17) $fy = Min(fy, 1.25*fy*(lb/ld)^{2/3}) = 311.2112$
   d = 907.00
    y = 0.25780424
   A = 0.0165657
   B = 0.00875687
    with pt = 0.0037716
       pc = 0.0037716
       pv = 0.00885172
       N = 21691.294
       b = 450.00
        " = 0.04740904
 y_comp = 9.5684630E-006
with fc* (12.3, (ACI 440)) = 33.31497
   fc = 33.00
   fl = 0.5419822
   b = bmax = 950.00
   h = hmax = 750.00
   Ag = 0.5625
     g = pt + pc + pv = 0.01639493
    rc = 40.00
    Ae/Ac = 0.29742395
    Effective FRP thickness, $tf = NL*t*Cos(b1) = 1.00$
   effective strain from (12.5) and (12.12), efe = 0.004
    fu = 0.009
  Ef = 82000.00
  Ec = 26999.444
   y = 0.25592203
  A = 0.01627529
  B = 0.0085861
   with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

 - Calculation of   p -

From table 10-8:   p = 0.03
with:
 - Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
  shear control ratio VyE/VCol0E = 0.3589236
  d = d_external = 907.00
  s = s_external = 0.00
 -   t =   s1 +   s2 + $2*tf/bw*(ffe/fs) = 0.00690186$
  jacket: s1 = Av1*Lstir1/(s1*Ag) = 0.00357443
      Av1 = 78.53982, is the area of every stirrup parallel to loading (shear) direction
      Lstir1 = 2560.00, is the total Length of all stirrups parallel to loading (shear) direction
      s1 = 100.00
  core: s2 = Av2*Lstir2/(s2*Ag) = 0.00070345
      Av2 = 50.26548, is the area of every stirrup parallel to loading (shear) direction
      Lstir2 = 1968.00, 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 = 21691.294
  Ag = 562500.00
  f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 33.00
  fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein = 555.56
  fytE = (fy_ext_Trans_Reinf* s1+fy_int_Trans_Reinf* s2)/(s1+ s2) = 555.56
pl = Area_Tot_Long_Rein/(b*d) = 0.01639493

b = 450.00
d = 907.00
f'cE = 33.00

End Of Calculation of Chord Rotation Capacity for element: column JTC1 of floor 1
At local axis: 3
Integration Section: (b)

End Of Calculation of Chord Rotation Capacity for element: column JTC1 of floor 1