Detailed Member Calculations

Units: N & mm

Regulation: ASCE 41-17

Calculation No. 1

column C1, Floor 1

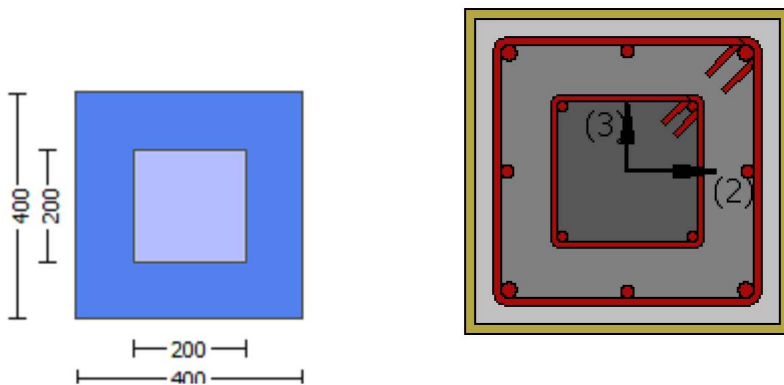Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (2)

Start Of Calculation of Shear Capacity for element: column JC1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rcjrs

Constant Properties

Knowledge Factor,   = 0.85
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
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of   y for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, 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 = 555.5556
Existing Column
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.4444
###
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups 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
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
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 = -1.3686E+007
Shear Force, Va = -4560.604
EDGE -B-
Bending Moment, Mb = 0.04224678
Shear Force, Vb = 4560.604
BOTH EDGES
Axial Force, F = -5974.983
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 1137.257
     -Compression: Aslc = 1539.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1137.257
     -Compression: Asl,com = 1137.257
         -Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL,ten = 16.80

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR =   *Vn = 409879.624
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 482211.322

VCol = 482211.322
knl = 1.00
   displacement_ductility_demand = 0.03204207

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 = 22.75, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
   Mu = 1.3686E+007
   Vu = 4560.604
  d = 0.8*h = 320.00
  Nu = 5974.983
  Ag = 160000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 251327.412
  where:
  Vs1 = 251327.412 is calculated for jacket, with:
   d = 320.00
   Av = 157079.633
   fy = 500.00
   s = 100.00
  Vs1 is multiplied by Col1 = 1.00
   s/d = 0.3125
  Vs2 = 0.00 is calculated for core, with:
   d = 160.00
   Av = 100530.965
   fy = 400.00
   s = 250.00
  Vs2 is multiplied by Col2 = 0.00
   s/d = 1.5625
  Vf ((11-3)-(11.4), ACI 440) = 188111.148
   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 = 1.016
  dfv = d (figure 11.2, ACI 440) = 357.00
  ffe ((11-5), ACI 440) = 259.312
   Ef = 64828.00
   fe = 0.004, from (11.6a), ACI 440
    with fu = 0.01
  From (11-11), ACI 440: Vs + Vf <= 405571.497
   bw = 400.00

----
displacement_ductility_demand is calculated as / y

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

From analysis, chord rotation = 0.0002277
 y = (My*Ls/3)/EIeff = 0.00710641 ((4.29),Biskinis Phd))
 My = 1.2106E+008
 Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3000.891
 From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7040E+013
  factor = 0.30
   Ag = 160000.00
   Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 29.75
   N = 5974.983
  Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.6801E+013

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7 -
----
 y = Min(y_ten, y_com)
 y_ten = 5.7839617E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 296.8901
    d = 357.00
     y = 0.28109392
    A = 0.01888489
    B = 0.01064175
     with pt = 0.00796398
        pc = 0.00796398
        pv = 0.00281599
        N = 5974.983
        b = 400.00
         " = 0.12044818
  y_comp = 2.3130538E-005
 with fc* (12.3, (ACI 440)) = 34.65043
     fc = 33.00
     fl = 0.93147527
     b = 400.00
     h = 400.00
     Ag = 160000.00
     From (12.9), ACI 440: ka = 0.56518315
        g = pt + pc + pv = 0.01874396
       rc = 40.00
       Ae/Ac = 0.56518315
       Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
     effective strain from (12.5) and (12.12), efe = 0.004
      fu = 0.01
     Ef = 64828.00
    Ec = 26999.444
     y = 0.27975148
    A = 0.01865339
    B = 0.01050082
     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 JC1 of floor 1
At local axis: 2
Integration Section: (a)

Calculation No. 2
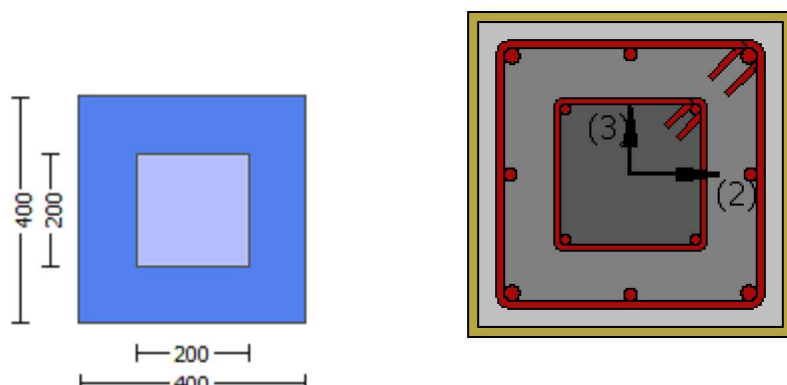
column C1, Floor 1

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 JC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcjrs

Constant Properties

Knowledge Factor,   = 0.85
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 = 555.5556
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.4444
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556
##
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.13212
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups 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
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
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 = -1.8468314E-031
EDGE -B-
Shear Force, Vb = 1.8468314E-031
BOTH EDGES
Axial Force, F = -5976.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
      -Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1137.257
      -Compression: Asl,com = 1137.257
        -Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.18171192
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 115036.425
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.7255E+008
  Mu1+ = 1.7255E+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- = 1.7255E+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-) = 1.7255E+008
  Mu2+ = 1.7255E+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- = 1.7255E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
    N = 5976.808
  fc = 33.00
    co (5A.5, TBDY) = 0.002

Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
  The Shear_factor is considered equal to 1 (pure moment strength)
  From (5.4b), TBDY: cu = 0.01608084
    we ((5.4c), TBDY) = ase* sh,min*fywe/fce+ Min(fx, fy) = 0.09892348
  where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
  ----
  fx = 0.07683125
  af = 0.57333333
      b = 400.00
      h = 400.00
   From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
      bw = 400.00
   effective stress from (A.35), ff,e = 870.5244
  ----
  fy = 0.07683125
  af = 0.57333333
      b = 400.00
      h = 400.00
   From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
      bw = 400.00
   effective stress from (A.35), ff,e = 870.5244

  R = 40.00
  Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
  fu,f = 1055.00
  Ef = 64828.00
   u,f = 0.015
  ase ((5.4d), TBDY) = (ase1*Aext+ ase2*Aint)/Asec = 0.24250288
      ase1 = 0.24250288
         bo_1 = 340.00
         ho_1 = 340.00
          bi2_1 = 462400.00
    ase2 = Max(ase1,ase2) = 0.24250288
         bo_2 = 192.00
         ho_2 = 192.00
          bi2_2 = 147456.00
  psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
  ----
  psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
    ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
        Ash1 = Astir_1*ns_1 = 157.0796
           No stirups, ns_1 = 2.00
        h1 = 400.00
    ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
        Ash2 = Astir_2*ns_2 = 100.531
           No stirups, ns_2 = 2.00
        h2 = 200.00
  ----
  psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
    ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
        Ash1 = Astir_1*ns_1 = 157.0796
           No stirups, ns_1 = 2.00
        h1 = 400.00
    ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
        Ash2 = Astir_2*ns_2 = 100.531
           No stirups, ns_2 = 2.00
        h2 = 200.00

      Asec = 160000.00
      s1 = 100.00
      s2 = 250.00
    fywe1 = 694.4444
    fywe2 = 555.5556
    fce = 33.00
  From ((5.A5), TBDY), TBDY: cc = 0.00332119
      c = confinement factor = 1.13212
  y1 = 0.00140044

sh1 = 0.0044814
ft1 = 441.538
fy1 = 367.9484
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 = 367.9484
   with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 441.538
fy2 = 367.9484
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 = 367.9484
   with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.813
fyv = 389.0108
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 = 389.0108
   with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
cc (5A.5, TBDY) = 0.00332119
  c = confinement factor = 1.13212
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.19835408

Mu = MRc (4.14) = 1.7255E+008
 φu = φsu (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
 φu = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
    N = 5976.808
  fc = 33.00
  εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.01608084
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.01608084
      ωwe ((5.4c), TBDY) = αse*ρsh,min*fywe/fce+Min(φfx, φfy) = 0.09892348
    where φf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

      φfx = 0.07683125
      αf = 0.57333333
        b = 400.00
        h = 400.00
      From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00508
        bw = 400.00
      effective stress from (A.35), ff,e = 870.5244

      φfy = 0.07683125
      αf = 0.57333333
        b = 400.00
        h = 400.00
      From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00508
        bw = 400.00
      effective stress from (A.35), ff,e = 870.5244

      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
      fu,f = 1055.00
      Ef = 64828.00
      εu,f = 0.015
      αse ((5.4d), TBDY) = (αse1*Aext+αse2*Aint)/Asec = 0.24250288
        αse1 = 0.24250288
          bo_1 = 340.00
          ho_1 = 340.00
           Σbi2_1 = 462400.00
        αse2 = Max(αse1,αse2) = 0.24250288
          bo_2 = 192.00
          ho_2 = 192.00
           Σbi2_2 = 147456.00
      ρsh,min*Fywe = Min(ρsh,x*Fywe , ρsh,y*Fywe) = 3.00633

      ρsh_x*Fywe = ρsh1*Fywe1+ρs2*Fywe2 = 3.00633
        ρs1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
          Ash1 = Astir_1*ns_1 = 157.0796

```
                No stirups, ns_1 = 2.00
             h1 = 400.00
          ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
             Ash2 = Astir_2*ns_2 = 100.531
                 No stirups, ns_2 = 2.00
             h2 = 200.00
      --------------------------------------------------------------
         psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
          ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
             Ash1 = Astir_1*ns_1 = 157.0796
                 No stirups, ns_1 = 2.00
             h1 = 400.00
          ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
             Ash2 = Astir_2*ns_2 = 100.531
                 No stirups, ns_2 = 2.00
             h2 = 200.00
      --------------------------------------------------------------
          Asec = 160000.00
          s1 = 100.00
          s2 = 250.00
        fywe1 = 694.4444
        fywe2 = 555.5556
        fce  = 33.00
     From ((5.A5), TBDY), TBDY:  cc = 0.00332119
          c  = confinement factor = 1.13212
   y1 = 0.00140044
   sh1 = 0.0044814
  ft1 = 441.538
  fy1 = 367.9484
   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 = 367.9484
      with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
   y2 = 0.00140044
   sh2 = 0.0044814
  ft2 = 441.538
  fy2 = 367.9484
   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 = 367.9484
      with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
   yv = 0.00140044
   shv = 0.0044814
  ftv = 466.813
  fyv = 389.0108
   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}, ρ_{shv},ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
ϵ_{y1}, ρ_{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 = 389.0108
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω_1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
ω_2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
ω_v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
  b = 340.00
  d = 327.00
  d' = 13.00
  fcc (5A.2, TBDY) = 37.35991
  ϵ_{cc} (5A.5, TBDY) = 0.00332119
    λ_c = confinement factor = 1.13212
    ω_1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
    ω_2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
    ω_v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
ω_v < $\omega_{vs,y2}$ - LHS eq.(4.5) is satisfied
--->
 ϵ_{su} (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
 ϕ_u = ϕ_{su} (4.1) = 1.7890363E-005

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 = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  ν = 0.00126831
    N = 5976.808
  fc = 33.00
  ϵ_{co} (5A.5, TBDY) = 0.002
  Final value of ϵ_{cu}: ϵ_{cu}* = shear_factor * Max(ϵ_{cu}, ϵ_{cc}) = 0.01608084
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: ϵ_{cu} = 0.01608084
      ω_{we} ((5.4c), TBDY) = α_{se}* $\rho_{sh,min}$*fywe/fce+Min(ω_{fx}, ω_{fy}) = 0.09892348
    where ω_f = α_f*ρ_f*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

      ω_{fx} = 0.07683125
      α_f = 0.57333333
        b = 400.00
        h = 400.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
        bw = 400.00
      effective stress from (A.35), ff,e = 870.5244

      ω_{fy} = 0.07683125

```
        af = 0.57333333
           b = 400.00
           h = 400.00
        From EC8 A 4.4.3(6), pf = 2tf/bw = 0.00508
           bw = 400.00
        effective stress from (A.35), ff,e = 870.5244
    -------------------------------------------------------------------
        R = 40.00
        Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
        fu,f = 1055.00
        Ef = 64828.00
         u,f = 0.015
        ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
           ase1 = 0.24250288
              bo_1 = 340.00
              ho_1 = 340.00
               bi2_1 = 462400.00
           ase2 = Max(ase1,ase2) = 0.24250288
              bo_2 = 192.00
              ho_2 = 192.00
               bi2_2 = 147456.00
        psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
    -------------------------------------------------------------------
        psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
           ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
              Ash1 = Astir_1*ns_1 = 157.0796
                 No stirups, ns_1 = 2.00
              h1 = 400.00
           ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
              Ash2 = Astir_2*ns_2 = 100.531
                 No stirups, ns_2 = 2.00
              h2 = 200.00
    -------------------------------------------------------------------
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
           ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
              Ash1 = Astir_1*ns_1 = 157.0796
                 No stirups, ns_1 = 2.00
              h1 = 400.00
           ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
              Ash2 = Astir_2*ns_2 = 100.531
                 No stirups, ns_2 = 2.00
              h2 = 200.00
    -------------------------------------------------------------------
        Asec = 160000.00
         s1 = 100.00
         s2 = 250.00
       fywe1 = 694.4444
       fywe2 = 555.5556
       fce  = 33.00
    From ((5.A5), TBDY), TBDY:  cc = 0.00332119
        c = confinement factor = 1.13212
  y1 = 0.00140044
  sh1 = 0.0044814
 ft1 = 441.538
 fy1 = 367.9484
  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 = 367.9484
     with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
```

y2 = 0.00140044
sh2 = 0.0044814
ft2 = 441.538
fy2 = 367.9484
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 = 367.9484
  with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.813
fyv = 389.0108
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 = 389.0108
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
 b = 340.00
 d = 327.00
 d' = 13.00
 fcc (5A.2, TBDY) = 37.35991
  cc (5A.5, TBDY) = 0.00332119
   c = confinement factor = 1.13212
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
  2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
  v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
 u = su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

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

u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
   N = 5976.808
  fc = 33.00
  co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.01608084
     we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.09892348
    where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----
    fx = 0.07683125
    af = 0.57333333
      b = 400.00
      h = 400.00
    From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
      bw = 400.00
    effective stress from (A.35), ff,e = 870.5244
    ----
    fy = 0.07683125
    af = 0.57333333
      b = 400.00
      h = 400.00
    From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
      bw = 400.00
    effective stress from (A.35), ff,e = 870.5244

    R = 40.00
    Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
    fu,f = 1055.00
    Ef = 64828.00
    u,f = 0.015
    ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
      ase1 = 0.24250288
        bo_1 = 340.00
        ho_1 = 340.00
         bi2_1 = 462400.00
     ase2 = Max(ase1,ase2) = 0.24250288
        bo_2 = 192.00
        ho_2 = 192.00
         bi2_2 = 147456.00
    psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
    ----
    psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
     ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
       Ash1 = Astir_1*ns_1 = 157.0796
         No stirups, ns_1 = 2.00
       h1 = 400.00
     ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
       Ash2 = Astir_2*ns_2 = 100.531
         No stirups, ns_2 = 2.00
       h2 = 200.00
    ----
    psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
     ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
       Ash1 = Astir_1*ns_1 = 157.0796
         No stirups, ns_1 = 2.00
       h1 = 400.00
     ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
       Ash2 = Astir_2*ns_2 = 100.531
         No stirups, ns_2 = 2.00

```
        h2 = 200.00
    ------------------------------------------------------------------
        Asec = 160000.00
         s1 = 100.00
         s2 = 250.00
      fywe1 = 694.4444
      fywe2 = 555.5556
        fce = 33.00
    From ((5.A5), TBDY):  cc = 0.00332119
        c = confinement factor = 1.13212
   y1 = 0.00140044
  sh1 = 0.0044814
 ft1 = 441.538
 fy1 = 367.9484
  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 = 367.9484
      with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
   y2 = 0.00140044
  sh2 = 0.0044814
 ft2 = 441.538
 fy2 = 367.9484
  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 = 367.9484
      with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
   yv = 0.00140044
  shv = 0.0044814
 ftv = 466.813
 fyv = 389.0108
  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 = 389.0108
      with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
    2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
    v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
  b = 340.00
  d = 327.00
  d' = 13.00
  fcc (5A.2, TBDY) = 37.35991
```

cc (5A.5, TBDY) = 0.00332119
        c = confinement factor = 1.13212
      1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
      2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
      v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
  u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 633070.334

Calculation of Shear Strength at edge 1, Vr1 = 633070.334
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 633070.334
  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 = 29.75, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
     Mu = 8.4878329E-012
     Vu = 1.8468314E-031
  d = 0.8*h = 320.00
  Nu = 5976.808
  Ag = 160000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279252.68
  where:
  Vs1 = 279252.68 is calculated for jacket, with:
    d = 320.00
    Av = 157079.633
    fy = 555.5556
    s = 100.00
  Vs1 is multiplied by Col1 = 1.00
    s/d = 0.3125
  Vs2 = 0.00 is calculated for core, with:
    d = 160.00
    Av = 100530.965
    fy = 444.4444
    s = 250.00
  Vs2 is multiplied by Col2 = 0.00
    s/d = 1.5625
  Vf ((11-3)-(11.4), ACI 440) = 188111.148
    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 = 1.016

dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
    Ef = 64828.00
     fe = 0.004, from (11.6a), ACI 440
       with fu = 0.01
  From (11-11), ACI 440: Vs + Vf <= 463788.751
    bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 633070.334
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 633070.334
  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 = 29.75, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
    Mu = 8.4878329E-012
    Vu = 1.8468314E-031
  d = 0.8*h = 320.00
  Nu = 5976.808
  Ag = 160000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279252.68
  where:
  Vs1 = 279252.68 is calculated for jacket, with:
    d = 320.00
    Av = 157079.633
    fy = 555.5556
    s = 100.00
  Vs1 is multiplied by Col1 = 1.00
    s/d = 0.3125
  Vs2 = 0.00 is calculated for core, with:
    d = 160.00
    Av = 100530.965
    fy = 444.4444
    s = 250.00
  Vs2 is multiplied by Col2 = 0.00
    s/d = 1.5625
  Vf ((11-3)-(11.4), ACI 440) = 188111.148
    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 = 1.016
  dfv = d (figure 11.2, ACI 440) = 357.00
  ffe ((11-5), ACI 440) = 259.312
    Ef = 64828.00
     fe = 0.004, from (11.6a), ACI 440
       with fu = 0.01
  From (11-11), ACI 440: Vs + Vf <= 463788.751
    bw = 400.00

End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjrs

Constant Properties

Knowledge Factor,   = 0.85
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 = 555.5556
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.4444
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556
##
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.13212
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups 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
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
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 = 3.2548216E-032
EDGE -B-
Shear Force, Vb = -3.2548216E-032
BOTH EDGES
Axial Force, F = -5976.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
    -Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: Asl,ten = 1137.257
      -Compression: Asl,com = 1137.257
         -Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.18171192
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 115036.425
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.7255E+008
   Mu1+ = 1.7255E+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- = 1.7255E+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-) = 1.7255E+008
   Mu2+ = 1.7255E+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- = 1.7255E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature   φu according to 4.1, Biskinis/Fardis 2013:
  φu = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  ν = 0.00126831
     N = 5976.808
  fc = 33.00
   εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.01608084
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: εcu = 0.01608084
       αωe ((5.4c), TBDY) = αse*ρsh,min*fywe/fce+Min(ρfx, ρfy) = 0.09892348
     where ρf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

       ρfx = 0.07683125
        αf = 0.57333333
           b = 400.00
           h = 400.00
        From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00508
           bw = 400.00
        effective stress from (A.35), ff,e = 870.5244

       ρfy = 0.07683125
        αf = 0.57333333
           b = 400.00
           h = 400.00
        From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00508
           bw = 400.00
        effective stress from (A.35), ff,e = 870.5244

       R = 40.00
       Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
       fu,f = 1055.00
       Ef = 64828.00
        εu,f = 0.015
       αse ((5.4d), TBDY) = (αse1*Aext+αse2*Aint)/Asec = 0.24250288

```
            ase1 = 0.24250288
              bo_1 = 340.00
              ho_1 = 340.00
               bi2_1 = 462400.00
          ase2 = Max(ase1,ase2) = 0.24250288
              bo_2 = 192.00
              ho_2 = 192.00
               bi2_2 = 147456.00
         psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
      -----------------------------------------------------------
         psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
            ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
               Ash1 = Astir_1*ns_1 = 157.0796
                  No stirups, ns_1 = 2.00
               h1 = 400.00
            ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
               Ash2 = Astir_2*ns_2 = 100.531
                  No stirups, ns_2 = 2.00
               h2 = 200.00
      -----------------------------------------------------------
         psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
            ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
               Ash1 = Astir_1*ns_1 = 157.0796
                  No stirups, ns_1 = 2.00
               h1 = 400.00
            ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
               Ash2 = Astir_2*ns_2 = 100.531
                  No stirups, ns_2 = 2.00
               h2 = 200.00
      -----------------------------------------------------------
            Asec = 160000.00
            s1 = 100.00
            s2 = 250.00
         fywe1 = 694.4444
         fywe2 = 555.5556
         fce  = 33.00
      From ((5.A5), TBDY), TBDY:  cc = 0.00332119
         c  = confinement factor = 1.13212
   y1 = 0.00140044
   sh1 = 0.0044814
  ft1 = 441.538
  fy1 = 367.9484
   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 = 367.9484
      with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
   y2 = 0.00140044
   sh2 = 0.0044814
  ft2 = 441.538
  fy2 = 367.9484
   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 = 367.9484
  with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
shv = 0.0044814
ftv = 466.813
fyv = 389.0108
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 = 389.0108
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
  2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
  v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
  b = 340.00
  d = 327.00
  d' = 13.00
  fcc (5A.2, TBDY) = 37.35991
  cc (5A.5, TBDY) = 0.00332119
    c = confinement factor = 1.13212
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
  2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
  v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
 u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
 u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
    N = 5976.808
  fc = 33.00
  co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
    The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: cu = 0.01608084
  we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.09892348
where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

----
  fx = 0.07683125
   af = 0.57333333
     b = 400.00
     h = 400.00
  From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
    bw = 400.00
  effective stress from (A.35), ff,e = 870.5244

----
  fy = 0.07683125
   af = 0.57333333
     b = 400.00
     h = 400.00
  From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
    bw = 400.00
  effective stress from (A.35), ff,e = 870.5244

  R = 40.00
  Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
  fu,f = 1055.00
  Ef = 64828.00
   u,f = 0.015
  ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
    ase1 = 0.24250288
      bo_1 = 340.00
      ho_1 = 340.00
       bi2_1 = 462400.00
    ase2 = Max(ase1,ase2) = 0.24250288
      bo_2 = 192.00
      ho_2 = 192.00
       bi2_2 = 147456.00
  psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633

----
  psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
    ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
      Ash1 = Astir_1*ns_1 = 157.0796
       No stirups, ns_1 = 2.00
      h1 = 400.00
    ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
      Ash2 = Astir_2*ns_2 = 100.531
       No stirups, ns_2 = 2.00
      h2 = 200.00

----
  psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
    ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
      Ash1 = Astir_1*ns_1 = 157.0796
       No stirups, ns_1 = 2.00
      h1 = 400.00
    ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
      Ash2 = Astir_2*ns_2 = 100.531
       No stirups, ns_2 = 2.00
      h2 = 200.00

    Asec = 160000.00
    s1 = 100.00
    s2 = 250.00
   fywe1 = 694.4444
   fywe2 = 555.5556
   fce = 33.00
 From ((5.A5), TBDY), TBDY: cc = 0.00332119
   c = confinement factor = 1.13212
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 441.538

fy1 = 367.9484
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 = 367.9484
  with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 441.538
fy2 = 367.9484
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 = 367.9484
  with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.813
fyv = 389.0108
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 = 389.0108
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
cc (5A.5, TBDY) = 0.00332119
  c = confinement factor = 1.13212
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
u =   su (4.1) = 1.7890363E-005

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

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


-------------------------------------------------------------------
Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.7890363E-005
Mu = 1.7255E+008
-------------------------------------------------------------------
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
    N = 5976.808
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of  cu:  cu* = shear_factor * Max( cu, cc) = 0.01608084
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY:  cu = 0.01608084
      we ((5.4c), TBDY) = ase*  sh,min*fywe/fce+Min(  fx,   fy) = 0.09892348
    where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----------------------------------------------------------------
      fx = 0.07683125
      af = 0.57333333
        b = 400.00
        h = 400.00
      From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
        bw = 400.00
      effective stress from (A.35), ff,e = 870.5244
    ----------------------------------------------------------------
      fy = 0.07683125
      af = 0.57333333
        b = 400.00
        h = 400.00
      From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
        bw = 400.00
      effective stress from (A.35), ff,e = 870.5244
    ----------------------------------------------------------------
      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
      fu,f = 1055.00
      Ef = 64828.00
       u,f = 0.015
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
        ase1 = 0.24250288
          bo_1 = 340.00
          ho_1 = 340.00
            bi2_1 = 462400.00
        ase2 = Max(ase1,ase2) = 0.24250288
            bo_2 = 192.00
            ho_2 = 192.00
              bi2_2 = 147456.00
      psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
    ----------------------------------------------------------------
      psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
        ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
          Ash1 = Astir_1*ns_1 = 157.0796
            No stirups, ns_1 = 2.00
          h1 = 400.00
```

```
           ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
               Ash2 = Astir_2*ns_2 = 100.531
                  No stirups, ns_2 = 2.00
               h2 = 200.00
       ------------------------------------------------------------
           psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
             ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
                 Ash1 = Astir_1*ns_1 = 157.0796
                    No stirups, ns_1 = 2.00
                 h1 = 400.00
             ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
                 Ash2 = Astir_2*ns_2 = 100.531
                    No stirups, ns_2 = 2.00
                 h2 = 200.00
       ------------------------------------------------------------
             Asec = 160000.00
             s1 = 100.00
             s2 = 250.00
           fywe1 = 694.4444
           fywe2 = 555.5556
           fce  = 33.00
       From ((5.A5), TBDY), TBDY:  cc = 0.00332119
             c  = confinement factor = 1.13212
    y1 = 0.00140044
    sh1 = 0.0044814
   ft1 = 441.538
   fy1 = 367.9484
    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 = 367.9484
         with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
    y2 = 0.00140044
    sh2 = 0.0044814
   ft2 = 441.538
   fy2 = 367.9484
    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 = 367.9484
         with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
    yv = 0.00140044
    shv = 0.0044814
   ftv = 466.813
   fyv = 389.0108
    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 = 389.0108
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
 2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
 v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
  b = 340.00
  d = 327.00
  d' = 13.00
  fcc (5A.2, TBDY) = 37.35991
   cc (5A.5, TBDY) = 0.00332119
      c = confinement factor = 1.13212
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
    2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
    v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
 u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
 u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
    N = 5976.808
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.01608084
     we ((5.4c), TBDY) = ase* sh,min*fywe/fce+ Min(fx,   fy) = 0.09892348
    where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
      ----
      fx = 0.07683125
       af = 0.57333333
          b = 400.00
          h = 400.00
       From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
          bw = 400.00
       effective stress from (A.35), ff,e = 870.5244
      ----
      fy = 0.07683125
       af = 0.57333333
          b = 400.00

h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244

R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
u,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
   ase1 = 0.24250288
      bo_1 = 340.00
      ho_1 = 340.00
       bi2_1 = 462400.00
   ase2 = Max(ase1,ase2) = 0.24250288
      bo_2 = 192.00
      ho_2 = 192.00
       bi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
   ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
      Ash1 = Astir_1*ns_1 = 157.0796
         No stirups, ns_1 = 2.00
      h1 = 400.00
   ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
      Ash2 = Astir_2*ns_2 = 100.531
         No stirups, ns_2 = 2.00
      h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
   ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
      Ash1 = Astir_1*ns_1 = 157.0796
         No stirups, ns_1 = 2.00
      h1 = 400.00
   ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
      Ash2 = Astir_2*ns_2 = 100.531
         No stirups, ns_2 = 2.00
      h2 = 200.00

   Asec = 160000.00
   s1 = 100.00
   s2 = 250.00
fywe1 = 694.4444
fywe2 = 555.5556
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00332119
   c = confinement factor = 1.13212
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 441.538
fy1 = 367.9484
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 = 367.9484
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814

ft2 = 441.538
fy2 = 367.9484
  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 = 367.9484
      with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00140044
  shv = 0.0044814
ftv = 466.813
fyv = 389.0108
  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 = 389.0108
      with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
  2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
  v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
  b = 340.00
  d = 327.00
  d' = 13.00
  fcc (5A.2, TBDY) = 37.35991
   cc (5A.5, TBDY) = 0.00332119
      c = confinement factor = 1.13212
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
    2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
    v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
 u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 633070.334

Calculation of Shear Strength at edge 1, Vr1 = 633070.334
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 633070.334
  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 = 29.75, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
  Mu = 1.4989884E-012
  Vu = 3.2548216E-032
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279252.68
where:
Vs1 = 279252.68 is calculated for jacket, with:
  d = 320.00
  Av = 157079.633
  fy = 555.5556
  s = 100.00
Vs1 is multiplied by   Col1 = 1.00
  s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
  d = 160.00
  Av = 100530.965
  fy = 444.4444
  s = 250.00
Vs2 is multiplied by   Col2 = 0.00
  s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
  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 +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 = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
  Ef = 64828.00
  εfe = 0.004, from (11.6a), ACI 440
    with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 463788.751
  bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 633070.334
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 633070.334
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 = 29.75, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
  Mu = 1.4989884E-012
  Vu = 3.2548216E-032
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279252.68
where:

Vs1 = 279252.68 is calculated for jacket, with:
    d = 320.00
    Av = 157079.633
    fy = 555.5556
    s = 100.00
  Vs1 is multiplied by   Col1 = 1.00
    s/d = 0.3125
  Vs2 = 0.00 is calculated for core, with:
    d = 160.00
    Av = 100530.965
    fy = 444.4444
    s = 250.00
  Vs2 is multiplied by   Col2 = 0.00
    s/d = 1.5625
  Vf ((11-3)-(11.4), ACI 440) = 188111.148
    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 = 1.016
  dfv = d (figure 11.2, ACI 440) = 357.00
  ffe ((11-5), ACI 440) = 259.312
    Ef = 64828.00
     fe = 0.004, from (11.6a), ACI 440
      with fu = 0.01
  From (11-11), ACI 440: Vs + Vf < = 463788.751
    bw = 400.00

End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rcjrs

Constant Properties

Knowledge Factor,   = 0.85
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 = 555.5556
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member

Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups 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
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
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 = -1.6937287E-010
Shear Force, V2 = -4560.604
Shear Force, V3 = 9.4294951E-014
Axial Force, F = -5974.983
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 1137.257
     -Compression: Aslc = 1539.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1137.257
     -Compression: Asl,com = 1137.257
        -Middle: Asl,mid = 402.1239
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,jacket = 829.3805
     -Compression: Asl,com,jacket = 829.3805
        -Middle: Asl,mid,jacket = 402.1239
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,core = 307.8761
     -Compression: Asl,com,core = 307.8761
        -Middle: Asl,mid,core = 0.00
Mean Diameter of Tension Reinforcement, DbL = 16.80

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity   u,R =   * u = 0.00301933
  u =   y +   p = 0.00355215

 - Calculation of   y -
----
  y = (My*Ls/3)/EIeff = 0.00355215 ((4.29),Biskinis Phd))
  My = 1.2106E+008
  Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
  From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7040E+013
     factor = 0.30
        Ag = 160000.00
        Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 29.75
        N = 5974.983
     Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.6801E+013

Calculation of Yielding Moment My

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

y_ten = 5.7839617E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 296.8901
    d = 357.00
     y = 0.28109392
    A = 0.01888489
    B = 0.01064175
     with pt = 0.00680079
        pc = 0.00796398
        pv = 0.00281599
        N = 5974.983
        b = 400.00
         " = 0.12044818
 y_comp = 2.3130538E-005
with fc* (12.3, (ACI 440)) = 34.65043
    fc = 33.00
    fl = 0.93147527
    b = 400.00
    h = 400.00
    Ag = 160000.00
    From (12.9), ACI 440: ka = 0.56518315
        g = pt + pc + pv = 0.01874396
       rc = 40.00
       Ae/Ac = 0.56518315
       Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
     effective strain from (12.5) and (12.12), efe = 0.004
      fu = 0.01
    Ef = 64828.00
    Ec = 26999.444
     y = 0.27975148
    A = 0.01865339
    B = 0.01050082
     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 = 0.18171192
 d = d_external = 357.00
 s = s_external = 0.00
  t = s1 + s2 + 2*tf/bw*(ffe/fs) = 0.00680079
 jacket: s1 = Av1*h1/(s1*Ag) = 0.00392699
      Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
      h1 = 400.00
      s1 = 100.00
  core: s2 = Av2*h2/(s2*Ag) = 0.00050265
      Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
      h2 = 200.00
      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 = 5974.983
   Ag = 160000.00
   f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 29.75
   fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein = 529.9948
   fytE = (fy_ext_Trans_Reinf*Area_ext_Trans_Reinf+fy_int_Trans_Reinf*Area_int_Trans_Reinf)/Area_Tot_Trans_Rein =

542.9472
pl = Area_Tot_Long_Rein/(b*d) = 0.01874396
   b = 400.00
   d = 357.00
   f'cE = 29.75

End Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 2
Integration Section: (a)

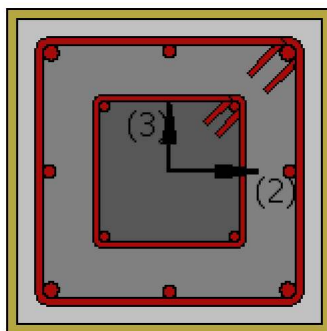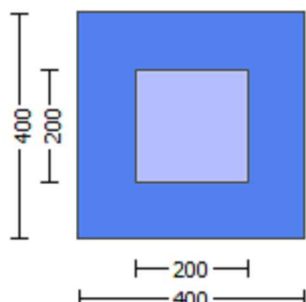
Calculation No. 3

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 JC1 of floor 1
At local axis: 3
Integration Section: (a)
Section Type: rcjrs

Constant Properties

Knowledge Factor,   = 0.85
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
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of y for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, 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 = 555.5556
Existing Column
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.4444
##
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups 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
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
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 = -1.6937287E-010
Shear Force, Va = 9.4294951E-014
EDGE -B-
Bending Moment, Mb = -1.1352078E-010
Shear Force, Vb = -9.4294951E-014
BOTH EDGES
Axial Force, F = -5974.983
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 1137.257
     -Compression: Aslc = 1539.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1137.257
     -Compression: Asl,com = 1137.257
         -Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL,ten = 16.80

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR =   *Vn = 475023.475
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 558851.147
   VCol = 558851.147
   knl = 1.00

displacement_ductility_demand = 0.00

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 = 22.75, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
    Mu = 1.6937287E-010
    Vu = 9.4294951E-014
  d = 0.8*h = 320.00
  Nu = 5974.983
  Ag = 160000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 251327.412
  where:
  Vs1 = 251327.412 is calculated for jacket, with:
    d = 320.00
    Av = 157079.633
    fy = 500.00
    s = 100.00
  Vs1 is multiplied by   Col1 = 1.00
    s/d = 0.3125
  Vs2 = 0.00 is calculated for core, with:
    d = 160.00
    Av = 100530.965
    fy = 400.00
    s = 250.00
  Vs2 is multiplied by   Col2 = 0.00
    s/d = 1.5625
  Vf ((11-3)-(11.4), ACI 440) = 188111.148
    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 = 1.016
  dfv = d (figure 11.2, ACI 440) = 357.00
  ffe ((11-5), ACI 440) = 259.312
    Ef = 64828.00
     fe = 0.004, from (11.6a), ACI 440
       with fu = 0.01
  From (11-11), ACI 440: Vs + Vf <= 405571.497
    bw = 400.00

----
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   = 5.1296730E-022
 y = (My*Ls/3)/EIeff = 0.00355215 ((4.29),Biskinis Phd))
  My = 1.2106E+008
  Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
  From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7040E+013
    factor = 0.30
      Ag = 160000.00
      Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 29.75
      N = 5974.983
    Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.6801E+013

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7 -
----
 y = Min(y_ten, y_com)
 y_ten = 5.7839617E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 296.8901
    d = 357.00
     y = 0.28109392
    A = 0.01888489
    B = 0.01064175
     with pt = 0.00796398
        pc = 0.00796398
        pv = 0.00281599
        N = 5974.983
        b = 400.00
         " = 0.12044818
 y_comp = 2.3130538E-005
 with fc* (12.3, (ACI 440)) = 34.65043
    fc = 33.00
    fl = 0.93147527
    b = 400.00
    h = 400.00
    Ag = 160000.00
    From (12.9), ACI 440: ka = 0.56518315
        g = pt + pc + pv = 0.01874396
       rc = 40.00
       Ae/Ac = 0.56518315
       Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
     effective strain from (12.5) and (12.12), efe = 0.004
      fu = 0.01
     Ef = 64828.00
    Ec = 26999.444
     y = 0.27975148
    A = 0.01865339
    B = 0.01050082
     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 JC1 of floor 1
At local axis: 3
Integration Section: (a)

Calculation No. 4
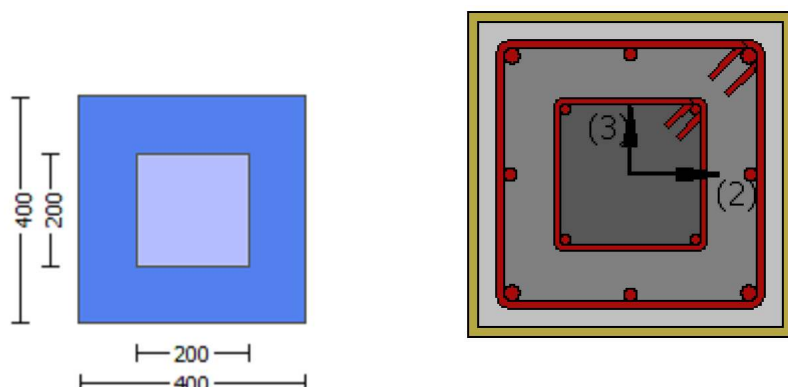
column C1, Floor 1

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 JC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcjrs

Constant Properties

Knowledge Factor,   = 0.85
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 = 555.5556
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.4444
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556
##
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.13212
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups 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
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
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 = -1.8468314E-031
EDGE -B-
Shear Force, Vb = 1.8468314E-031
BOTH EDGES
Axial Force, F = -5976.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1137.257
     -Compression: Asl,com = 1137.257
        -Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.18171192
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 115036.425
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.7255E+008
   Mu1+ = 1.7255E+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- = 1.7255E+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-) = 1.7255E+008
   Mu2+ = 1.7255E+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- = 1.7255E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
   u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
   b = 400.00
   d = 357.00
   d' = 43.00
   v = 0.00126831
     N = 5976.808
   fc = 33.00
     co (5A.5, TBDY) = 0.002

Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.01608084
       we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx,   fy) = 0.09892348
    where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----
    fx = 0.07683125
     af = 0.57333333
        b = 400.00
        h = 400.00
     From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
        bw = 400.00
     effective stress from (A.35), ff,e = 870.5244
    ----
    fy = 0.07683125
     af = 0.57333333
        b = 400.00
        h = 400.00
     From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
        bw = 400.00
     effective stress from (A.35), ff,e = 870.5244

    R = 40.00
    Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
    fu,f = 1055.00
    Ef = 64828.00
     u,f = 0.015
    ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
       ase1 = 0.24250288
          bo_1 = 340.00
          ho_1 = 340.00
           bi2_1 = 462400.00
       ase2 = Max(ase1,ase2) = 0.24250288
           bo_2 = 192.00
           ho_2 = 192.00
            bi2_2 = 147456.00
    psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
    ----
    psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
       ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
          Ash1 = Astir_1*ns_1 = 157.0796
             No stirups, ns_1 = 2.00
          h1 = 400.00
       ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
          Ash2 = Astir_2*ns_2 = 100.531
             No stirups, ns_2 = 2.00
          h2 = 200.00
    ----
    psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
       ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
          Ash1 = Astir_1*ns_1 = 157.0796
             No stirups, ns_1 = 2.00
          h1 = 400.00
       ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
          Ash2 = Astir_2*ns_2 = 100.531
             No stirups, ns_2 = 2.00
          h2 = 200.00

        Asec = 160000.00
        s1 = 100.00
        s2 = 250.00
      fywe1 = 694.4444
      fywe2 = 555.5556
      fce = 33.00
    From ((5.A5), TBDY), TBDY: cc = 0.00332119
        c = confinement factor = 1.13212
   y1 = 0.00140044

sh1 = 0.0044814
   ft1 = 441.538
   fy1 = 367.9484
    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 = 367.9484
        with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
    y2 = 0.00140044
     sh2 = 0.0044814
   ft2 = 441.538
   fy2 = 367.9484
    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 = 367.9484
        with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
    yv = 0.00140044
     shv = 0.0044814
   ftv = 466.813
   fyv = 389.0108
    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 = 389.0108
        with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
     2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
     v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
   b = 340.00
   d = 327.00
   d' = 13.00
   fcc (5A.2, TBDY) = 37.35991
    cc (5A.5, TBDY) = 0.00332119
       c = confinement factor = 1.13212
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
     2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
     v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408

Mu = MRc (4.14) = 1.7255E+008
 u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
 u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
    N = 5976.808
 fc = 33.00
  co (5A.5, TBDY) = 0.002
 Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.01608084
     we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx,   fy) = 0.09892348
    where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
     ----
      fx = 0.07683125
      af = 0.57333333
         b = 400.00
         h = 400.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
         bw = 400.00
      effective stress from (A.35), ff,e = 870.5244
     ----
      fy = 0.07683125
      af = 0.57333333
         b = 400.00
         h = 400.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
         bw = 400.00
      effective stress from (A.35), ff,e = 870.5244

      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
      fu,f = 1055.00
      Ef = 64828.00
       u,f = 0.015
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
         ase1 = 0.24250288
            bo_1 = 340.00
            ho_1 = 340.00
             bi2_1 = 462400.00
         ase2 = Max(ase1,ase2) = 0.24250288
             bo_2 = 192.00
             ho_2 = 192.00
              bi2_2 = 147456.00
      psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
     ----
      psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
        ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
            Ash1 = Astir_1*ns_1 = 157.0796

No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.4444
fywe2 = 555.5556
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00332119
c = confinement factor = 1.13212
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 441.538
fy1 = 367.9484
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 = 367.9484
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 441.538
fy2 = 367.9484
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 = 367.9484
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.813
fyv = 389.0108
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 ωyv, ωshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
ωy1, ωsh1,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 = 389.0108
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
αc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
' satisfies Eq. (4.3)
--->
εv < εvs,y2 - LHS eq.(4.5) is satisfied
--->
εsu (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
φu = φsu (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
ν = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.01608084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01608084
ωwe ((5.4c), TBDY) = αse*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.09892348
where ωf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.07683125
αf = 0.57333333
b = 400.00
h = 400.00
From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244

ωfy = 0.07683125

43

```
        af = 0.57333333
         b = 400.00
         h = 400.00
      From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
         bw = 400.00
      effective stress from (A.35), ff,e = 870.5244
  -------------------------------------------------------------------
      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
      fu,f = 1055.00
      Ef = 64828.00
       u,f = 0.015
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
         ase1 = 0.24250288
            bo_1 = 340.00
            ho_1 = 340.00
             bi2_1 = 462400.00
         ase2 = Max(ase1,ase2) = 0.24250288
             bo_2 = 192.00
             ho_2 = 192.00
              bi2_2 = 147456.00
      psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
  -------------------------------------------------------------------
      psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
         ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
            Ash1 = Astir_1*ns_1 = 157.0796
               No stirups, ns_1 = 2.00
            h1 = 400.00
         ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
            Ash2 = Astir_2*ns_2 = 100.531
               No stirups, ns_2 = 2.00
            h2 = 200.00
  -------------------------------------------------------------------
      psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
         ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
            Ash1 = Astir_1*ns_1 = 157.0796
               No stirups, ns_1 = 2.00
            h1 = 400.00
         ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
            Ash2 = Astir_2*ns_2 = 100.531
               No stirups, ns_2 = 2.00
            h2 = 200.00
  -------------------------------------------------------------------
         Asec = 160000.00
         s1 = 100.00
         s2 = 250.00
      fywe1 = 694.4444
      fywe2 = 555.5556
      fce = 33.00
   From ((5.A5), TBDY), TBDY:  cc = 0.00332119
         c = confinement factor = 1.13212
  y1 = 0.00140044
 sh1 = 0.0044814
ft1 = 441.538
fy1 = 367.9484
 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 = 367.9484
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
```

y2 = 0.00140044
sh2 = 0.0044814
ft2 = 441.538
fy2 = 367.9484
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 = 367.9484
   with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.813
fyv = 389.0108
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 = 389.0108
   with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
  2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
  v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
 b = 340.00
 d = 327.00
 d' = 13.00
 fcc (5A.2, TBDY) = 37.35991
  cc (5A.5, TBDY) = 0.00332119
   c = confinement factor = 1.13212
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
  2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
  v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
 u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

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

```
  u = 1.7890363E-005
Mu = 1.7255E+008
------------------------------------------------------------------------
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
    N = 5976.808
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of  cu:  cu* = shear_factor * Max( cu, cc) = 0.01608084
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY:  cu = 0.01608084
        we ((5.4c), TBDY) = ase*  sh,min*fywe/fce+Min(  fx,   fy) = 0.09892348
     where    f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
     ------------------------------------------------------------------
        fx = 0.07683125
        af = 0.57333333
           b = 400.00
           h = 400.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
           bw = 400.00
        effective stress from (A.35), ff,e = 870.5244
     ------------------------------------------------------------------
        fy = 0.07683125
        af = 0.57333333
           b = 400.00
           h = 400.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
           bw = 400.00
        effective stress from (A.35), ff,e = 870.5244
     ------------------------------------------------------------------
        R = 40.00
        Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
        fu,f = 1055.00
        Ef = 64828.00
         u,f = 0.015
        ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
           ase1 = 0.24250288
              bo_1 = 340.00
              ho_1 = 340.00
               bi2_1 = 462400.00
        ase2 = Max(ase1,ase2) = 0.24250288
              bo_2 = 192.00
              ho_2 = 192.00
               bi2_2 = 147456.00
        psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
     ------------------------------------------------------------------
        psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
           ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
              Ash1 = Astir_1*ns_1 = 157.0796
                 No stirups, ns_1 = 2.00
              h1 = 400.00
           ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
              Ash2 = Astir_2*ns_2 = 100.531
                 No stirups, ns_2 = 2.00
              h2 = 200.00
     ------------------------------------------------------------------
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
           ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
              Ash1 = Astir_1*ns_1 = 157.0796
                 No stirups, ns_1 = 2.00
              h1 = 400.00
           ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
              Ash2 = Astir_2*ns_2 = 100.531
                 No stirups, ns_2 = 2.00
```

```
          h2 = 200.00
    ----------------------------------------------------------------
          Asec = 160000.00
           s1 = 100.00
           s2 = 250.00
        fywe1 = 694.4444
        fywe2 = 555.5556
         fce = 33.00
      From ((5.A5), TBDY):  cc = 0.00332119
          c  = confinement factor = 1.13212
    y1 = 0.00140044
    sh1 = 0.0044814
  ft1 = 441.538
  fy1 = 367.9484
   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 = 367.9484
       with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
    y2 = 0.00140044
    sh2 = 0.0044814
  ft2 = 441.538
  fy2 = 367.9484
   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 = 367.9484
       with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
    yv = 0.00140044
    shv = 0.0044814
  ftv = 466.813
  fyv = 389.0108
   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 = 389.0108
       with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
     2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
     v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
  b = 340.00
  d = 327.00
  d' = 13.00
  fcc (5A.2, TBDY) = 37.35991
```

cc (5A.5, TBDY) = 0.00332119
    c = confinement factor = 1.13212
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
    2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
    v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
  u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 633070.334

Calculation of Shear Strength at edge 1, Vr1 = 633070.334
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 633070.334
  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 = 29.75, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
    Mu = 8.4878329E-012
    Vu = 1.8468314E-031
  d = 0.8*h = 320.00
  Nu = 5976.808
  Ag = 160000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279252.68
  where:
  Vs1 = 279252.68 is calculated for jacket, with:
    d = 320.00
    Av = 157079.633
    fy = 555.5556
    s = 100.00
  Vs1 is multiplied by   Col1 = 1.00
    s/d = 0.3125
  Vs2 = 0.00 is calculated for core, with:
    d = 160.00
    Av = 100530.965
    fy = 444.4444
    s = 250.00
  Vs2 is multiplied by   Col2 = 0.00
    s/d = 1.5625
  Vf ((11-3)-(11.4), ACI 440) = 188111.148
    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 = 1.016

```
   dfv = d (figure 11.2, ACI 440) = 357.00
   ffe ((11-5), ACI 440) = 259.312
      Ef = 64828.00
       fe = 0.004, from (11.6a), ACI 440
         with   fu = 0.01
   From (11-11), ACI 440: Vs + Vf < = 463788.751
      bw = 400.00
------------------------------------------------------------
-------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 633070.334
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
   VCol0 = 633070.334
   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 = 29.75, but fc^0.5 < = 8.3
MPa (22.5.3.1, ACI 318-14)
   M/Vd = 2.00
      Mu = 8.4878329E-012
      Vu = 1.8468314E-031
   d = 0.8*h = 320.00
   Nu = 5976.808
   Ag = 160000.00
   From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279252.68
   where:
   Vs1 = 279252.68 is calculated for jacket, with:
     d = 320.00
     Av = 157079.633
     fy = 555.5556
     s = 100.00
   Vs1 is multiplied by   Col1 = 1.00
      s/d = 0.3125
   Vs2 = 0.00 is calculated for core, with:
     d = 160.00
     Av = 100530.965
     fy = 444.4444
     s = 250.00
   Vs2 is multiplied by   Col2 = 0.00
      s/d = 1.5625
   Vf ((11-3)-(11.4), ACI 440) = 188111.148
      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 = 1.016
   dfv = d (figure 11.2, ACI 440) = 357.00
   ffe ((11-5), ACI 440) = 259.312
      Ef = 64828.00
       fe = 0.004, from (11.6a), ACI 440
         with   fu = 0.01
   From (11-11), ACI 440: Vs + Vf < = 463788.751
      bw = 400.00
------------------------------------------------------------
-------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 3


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

Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjrs

Constant Properties

Knowledge Factor,   = 0.85
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 = 555.5556
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.4444
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556
##
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.13212
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups 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
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
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 = 3.2548216E-032
EDGE -B-
Shear Force, Vb = -3.2548216E-032
BOTH EDGES
Axial Force, F = -5976.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
       -Tension: Aslt = 0.00
     -Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)

```
        -Tension: Asl,ten = 1137.257
     -Compression: Asl,com = 1137.257
        -Middle: Asl,mid = 402.1239
-------------------------------------------------------------
-------------------------------------------------------------
```

Calculation of Shear Capacity ratio , Ve/Vr = 0.18171192
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 115036.425
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.7255E+008
   Mu1+ = 1.7255E+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- = 1.7255E+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-) = 1.7255E+008
   Mu2+ = 1.7255E+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- = 1.7255E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
    N = 5976.808
  fc = 33.00
   εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.01608084
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.01608084
      ωwe ((5.4c), TBDY) = αse*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.09892348
    where ωf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

      ωfx = 0.07683125
       αf = 0.57333333
          b = 400.00
          h = 400.00
        From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00508
          bw = 400.00
        effective stress from (A.35), ff,e = 870.5244

      ωfy = 0.07683125
       αf = 0.57333333
          b = 400.00
          h = 400.00
        From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00508
          bw = 400.00
        effective stress from (A.35), ff,e = 870.5244

      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
      fu,f = 1055.00
      Ef = 64828.00
       εu,f = 0.015
      αse ((5.4d), TBDY) = (αse1*Aext+αse2*Aint)/Asec = 0.24250288
```

ase1 = 0.24250288
            bo_1 = 340.00
            ho_1 = 340.00
             bi2_1 = 462400.00
       ase2 = Max(ase1,ase2) = 0.24250288
            bo_2 = 192.00
            ho_2 = 192.00
             bi2_2 = 147456.00
       psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
    -----------------------------------------------------------------
       psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
          ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
            Ash1 = Astir_1*ns_1 = 157.0796
               No stirups, ns_1 = 2.00
            h1 = 400.00
          ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
            Ash2 = Astir_2*ns_2 = 100.531
               No stirups, ns_2 = 2.00
            h2 = 200.00
    -----------------------------------------------------------------
       psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
          ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
            Ash1 = Astir_1*ns_1 = 157.0796
               No stirups, ns_1 = 2.00
            h1 = 400.00
          ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
            Ash2 = Astir_2*ns_2 = 100.531
               No stirups, ns_2 = 2.00
            h2 = 200.00
    -----------------------------------------------------------------
         Asec = 160000.00
         s1 = 100.00
         s2 = 250.00
      fywe1 = 694.4444
      fywe2 = 555.5556
      fce = 33.00
    From ((5.A5), TBDY), TBDY:  cc = 0.00332119
        c = confinement factor = 1.13212
  y1 = 0.00140044
  sh1 = 0.0044814
 ft1 = 441.538
 fy1 = 367.9484
  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 = 367.9484
     with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.00140044
  sh2 = 0.0044814
 ft2 = 441.538
 fy2 = 367.9484
  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 = 367.9484
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00140044
  shv = 0.0044814
ftv = 466.813
fyv = 389.0108
 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 = 389.0108
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
  2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
  v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
  b = 340.00
  d = 327.00
  d' = 13.00
  fcc (5A.2, TBDY) = 37.35991
   cc (5A.5, TBDY) = 0.00332119
     c  = confinement factor = 1.13212
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
   2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
   v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
 u =  su (4.1) = 1.7890363E-005
-----------------------------------------------------------

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

---------------------------------------------------------------------------
Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.7890363E-005
Mu = 1.7255E+008
---------------------------------------------------------------------------
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
    N = 5976.808
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of  cu:  cu* = shear_factor * Max( cu, cc) = 0.01608084
    The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY:  cu = 0.01608084
  we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min( fx, fy) = 0.09892348
where  f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
-----------------------------------------------------------------

  fx = 0.07683125
  af = 0.57333333
    b = 400.00
    h = 400.00
  From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
    bw = 400.00
  effective stress from (A.35), ff,e = 870.5244
-----------------------------------------------------------------

  fy = 0.07683125
  af = 0.57333333
    b = 400.00
    h = 400.00
  From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
    bw = 400.00
  effective stress from (A.35), ff,e = 870.5244
-----------------------------------------------------------------

  R = 40.00
  Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
  fu,f = 1055.00
  Ef = 64828.00
   u,f = 0.015
  ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
    ase1 = 0.24250288
      bo_1 = 340.00
      ho_1 = 340.00
       bi2_1 = 462400.00
    ase2 = Max(ase1,ase2) = 0.24250288
      bo_2 = 192.00
      ho_2 = 192.00
       bi2_2 = 147456.00
  psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
-----------------------------------------------------------------

  psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
    ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
      Ash1 = Astir_1*ns_1 = 157.0796
        No stirups, ns_1 = 2.00
      h1 = 400.00
    ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
      Ash2 = Astir_2*ns_2 = 100.531
        No stirups, ns_2 = 2.00
      h2 = 200.00
-----------------------------------------------------------------

  psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
    ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
      Ash1 = Astir_1*ns_1 = 157.0796
        No stirups, ns_1 = 2.00
      h1 = 400.00
    ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
      Ash2 = Astir_2*ns_2 = 100.531
        No stirups, ns_2 = 2.00
      h2 = 200.00
-----------------------------------------------------------------

    Asec = 160000.00
    s1 = 100.00
    s2 = 250.00
  fywe1 = 694.4444
  fywe2 = 555.5556
  fce = 33.00
From ((5.A5), TBDY), TBDY:  cc = 0.00332119
   c = confinement factor = 1.13212
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 441.538

fy1 = 367.9484
 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 = 367.9484
     with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.00140044
  sh2 = 0.0044814
 ft2 = 441.538
 fy2 = 367.9484
  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 = 367.9484
     with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00140044
  shv = 0.0044814
 ftv = 466.813
 fyv = 389.0108
  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 = 389.0108
     with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
   2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
   v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
  b = 340.00
  d = 327.00
  d' = 13.00
  fcc (5A.2, TBDY) = 37.35991
   cc (5A.5, TBDY) = 0.00332119
      c = confinement factor = 1.13212
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
   2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
   v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
 u =   su (4.1) = 1.7890363E-005

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

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


-----------------------------------------------------------------------
Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.7890363E-005
Mu = 1.7255E+008
-----------------------------------------------------------------------
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
    N = 5976.808
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of  cu:  cu* = shear_factor * Max( cu,  cc) = 0.01608084
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY:  cu = 0.01608084
       we ((5.4c), TBDY) = ase*  sh,min*fywe/fce+Min(  fx,   fy) = 0.09892348
     where    f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
     ---------------------------------------------------------------
       fx = 0.07683125
        af = 0.57333333
           b = 400.00
           h = 400.00
        From EC8 A 4.4.3(6), pf = 2tf/bw = 0.00508
           bw = 400.00
        effective stress from (A.35), ff,e = 870.5244
     ---------------------------------------------------------------
       fy = 0.07683125
        af = 0.57333333
           b = 400.00
           h = 400.00
        From EC8 A 4.4.3(6), pf = 2tf/bw = 0.00508
           bw = 400.00
        effective stress from (A.35), ff,e = 870.5244
     ---------------------------------------------------------------
        R = 40.00
        Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
        fu,f = 1055.00
        Ef = 64828.00
         u,f = 0.015
        ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
           ase1 = 0.24250288
              bo_1 = 340.00
              ho_1 = 340.00
                bi2_1 = 462400.00
        ase2 = Max(ase1,ase2) = 0.24250288
              bo_2 = 192.00
              ho_2 = 192.00
                bi2_2 = 147456.00
        psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
     ---------------------------------------------------------------
        psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
          ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
             Ash1 = Astir_1*ns_1 = 157.0796
                No stirups, ns_1 = 2.00
             h1 = 400.00

```
                ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
                    Ash2 = Astir_2*ns_2 = 100.531
                        No stirups, ns_2 = 2.00
                    h2 = 200.00
            ---------------------------------------------------------------
                psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
                    ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
                        Ash1 = Astir_1*ns_1 = 157.0796
                            No stirups, ns_1 = 2.00
                        h1 = 400.00
                    ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
                        Ash2 = Astir_2*ns_2 = 100.531
                            No stirups, ns_2 = 2.00
                        h2 = 200.00
            ---------------------------------------------------------------
                Asec = 160000.00
                s1 = 100.00
                s2 = 250.00
            fywe1 = 694.4444
            fywe2 = 555.5556
            fce = 33.00
        From ((5.A5), TBDY), TBDY:  cc = 0.00332119
            c = confinement factor = 1.13212
    y1 = 0.00140044
    sh1 = 0.0044814
ft1 = 441.538
fy1 = 367.9484
    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 = 367.9484
            with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
    y2 = 0.00140044
    sh2 = 0.0044814
ft2 = 441.538
fy2 = 367.9484
    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 = 367.9484
            with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
    yv = 0.00140044
    shv = 0.0044814
ftv = 466.813
fyv = 389.0108
    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 = 389.0108
   with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
  2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
  v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
  b = 340.00
  d = 327.00
  d' = 13.00
  fcc (5A.2, TBDY) = 37.35991
   cc (5A.5, TBDY) = 0.00332119
     c = confinement factor = 1.13212
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
    2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
    v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
 v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
  u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
    N = 5976.808
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of   cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.01608084
     we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx,   fy) = 0.09892348
    where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
      ----
      fx = 0.07683125
       af = 0.57333333
          b = 400.00
          h = 400.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
          bw = 400.00
        effective stress from (A.35), ff,e = 870.5244
      ----
      fy = 0.07683125
       af = 0.57333333
          b = 400.00

```
        h = 400.00
     From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
        bw = 400.00
     effective stress from (A.35), ff,e = 870.5244
   ----------------------------------------------------------------
     R = 40.00
     Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
     fu,f = 1055.00
     Ef = 64828.00
      u,f = 0.015
     ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
        ase1 = 0.24250288
           bo_1 = 340.00
           ho_1 = 340.00
            bi2_1 = 462400.00
        ase2 = Max(ase1,ase2) = 0.24250288
           bo_2 = 192.00
           ho_2 = 192.00
            bi2_2 = 147456.00
     psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
   ----------------------------------------------------------------
     psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
        ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
           Ash1 = Astir_1*ns_1 = 157.0796
              No stirups, ns_1 = 2.00
           h1 = 400.00
        ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
           Ash2 = Astir_2*ns_2 = 100.531
              No stirups, ns_2 = 2.00
           h2 = 200.00
   ----------------------------------------------------------------
     psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
        ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
           Ash1 = Astir_1*ns_1 = 157.0796
              No stirups, ns_1 = 2.00
           h1 = 400.00
        ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
           Ash2 = Astir_2*ns_2 = 100.531
              No stirups, ns_2 = 2.00
           h2 = 200.00
   ----------------------------------------------------------------
        Asec = 160000.00
        s1 = 100.00
        s2 = 250.00
     fywe1 = 694.4444
     fywe2 = 555.5556
     fce = 33.00
   From ((5.A5), TBDY), TBDY:  cc = 0.00332119
        c = confinement factor = 1.13212
  y1 = 0.00140044
 sh1 = 0.0044814
ft1 = 441.538
fy1 = 367.9484
 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 = 367.9484
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
 y2 = 0.00140044
sh2 = 0.0044814
```

```
    ft2 = 441.538
    fy2 = 367.9484
     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 = 367.9484
         with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
     yv = 0.00140044
     shv = 0.0044814
    ftv = 466.813
    fyv = 389.0108
     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 = 389.0108
         with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
     2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
     v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
   b = 340.00
   d = 327.00
   d' = 13.00
   fcc (5A.2, TBDY) = 37.35991
    cc (5A.5, TBDY) = 0.00332119
       c  = confinement factor = 1.13212
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
     2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
     v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
  u =   su (4.1) = 1.7890363E-005
--------------------------------------------------------------

Calculation of ratio lb/ld
--------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
-----------------------------------------------------------------------
-----------------------------------------------------------------------
-----------------------------------------------------------------------
-----------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 633070.334
-----------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 633070.334
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 633070.334
  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 = 29.75, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
  Mu = 1.4989884E-012
  Vu = 3.2548216E-032
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279252.68
where:
Vs1 = 279252.68 is calculated for jacket, with:
  d = 320.00
  Av = 157079.633
  fy = 555.5556
  s = 100.00
Vs1 is multiplied by Col1 = 1.00
  s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
  d = 160.00
  Av = 100530.965
  fy = 444.4444
  s = 250.00
Vs2 is multiplied by Col2 = 0.00
  s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
  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 = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
  Ef = 64828.00
   fe = 0.004, from (11.6a), ACI 440
    with fu = 0.01
From (11-11), ACI 440: Vs + Vf <= 463788.751
  bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 633070.334
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 633070.334
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 = 29.75, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
  Mu = 1.4989884E-012
  Vu = 3.2548216E-032
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279252.68
where:

Vs1 = 279252.68 is calculated for jacket, with:
   d = 320.00
   Av = 157079.633
   fy = 555.5556
   s = 100.00
  Vs1 is multiplied by   Col1 = 1.00
   s/d = 0.3125
  Vs2 = 0.00 is calculated for core, with:
   d = 160.00
   Av = 100530.965
   fy = 444.4444
   s = 250.00
  Vs2 is multiplied by   Col2 = 0.00
   s/d = 1.5625
  Vf ((11-3)-(11.4), ACI 440) = 188111.148
   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 = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
   Ef = 64828.00
    fe = 0.004, from (11.6a), ACI 440
     with fu = 0.01
 From (11-11), ACI 440: Vs + Vf <= 463788.751
   bw = 400.00

End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 3
Integration Section: (a)
Section Type: rcjrs

Constant Properties

Knowledge Factor, = 0.85
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 = 555.5556
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member

Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups 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
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
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 = -1.3686E+007
Shear Force, V2 = -4560.604
Shear Force, V3 = 9.4294951E-014
Axial Force, F = -5974.983
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 1137.257
     -Compression: Aslc = 1539.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1137.257
     -Compression: Asl,com = 1137.257
        -Middle: Asl,mid = 402.1239
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,jacket = 829.3805
     -Compression: Asl,com,jacket = 829.3805
        -Middle: Asl,mid,jacket = 402.1239
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,core = 307.8761
     -Compression: Asl,com,core = 307.8761
        -Middle: Asl,mid,core = 0.00
Mean Diameter of Tension Reinforcement, DbL = 16.80

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity   u,R =   * u = 0.00604045
 u = y + p = 0.00710641

 - Calculation of y -
----
 y = (My*Ls/3)/EIeff = 0.00710641 ((4.29),Biskinis Phd))
 My = 1.2106E+008
 Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3000.891
 From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7040E+013
    factor = 0.30
       Ag = 160000.00
       Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 29.75
       N = 5974.983
    Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.6801E+013

Calculation of Yielding Moment My

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

y_ten = 5.7839617E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 296.8901
   d = 357.00
    y = 0.28109392
   A = 0.01888489
   B = 0.01064175
    with pt = 0.00680079
       pc = 0.00796398
       pv = 0.00281599
       N = 5974.983
       b = 400.00
        " = 0.12044818
 y_comp = 2.3130538E-005
with fc* (12.3, (ACI 440)) = 34.65043
   fc = 33.00
   fl = 0.93147527
   b = 400.00
   h = 400.00
   Ag = 160000.00
   From (12.9), ACI 440: ka = 0.56518315
     g = pt + pc + pv = 0.01874396
    rc = 40.00
    Ae/Ac = 0.56518315
    Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
   effective strain from (12.5) and (12.12), efe = 0.004
    fu = 0.01
  Ef = 64828.00
  Ec = 26999.444
   y = 0.27975148
  A = 0.01865339
  B = 0.01050082
   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 = 0.18171192
 d = d_external = 357.00
 s = s_external = 0.00
  t =   s1 +   s2 + 2*tf/bw*(ffe/fs) = 0.00680079
 jacket: s1 = Av1*h1/(s1*Ag) = 0.00392699
      Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
      h1 = 400.00
      s1 = 100.00
 core: s2 = Av2*h2/(s2*Ag) = 0.00050265
      Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
      h2 = 200.00
      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 = 5974.983
  Ag = 160000.00
  f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 29.75
  fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein =
529.9948
  fytE = (fy_ext_Trans_Reinf*Area_ext_Trans_Reinf+fy_int_Trans_Reinf*Area_int_Trans_Reinf)/Area_Tot_Trans_Rein =

542.9472
pl = Area_Tot_Long_Rein/(b*d) = 0.01874396
  b = 400.00
  d = 357.00
   f'cE = 29.75

End Of Calculation of Chord Rotation Capacity for element: column JC1 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 JC1 of floor 1
At local axis: 2
Integration Section: (b)
Section Type: rcjrs

Constant Properties

Knowledge Factor,   = 0.85
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
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of y for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, 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 = 555.5556
Existing Column
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.4444
##
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups 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
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
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 = -1.3686E+007
Shear Force, Va = -4560.604
EDGE -B-
Bending Moment, Mb = 0.04224678
Shear Force, Vb = 4560.604
BOTH EDGES
Axial Force, F = -5974.983
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1137.257
     -Compression: Asl,com = 1137.257
         -Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL,ten = 16.80

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR =   *Vn = 475023.475
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 558851.147
   VCol = 558851.147
   knl = 1.00

displacement_ductility_demand = 0.16955779

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 = 22.75, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
    Mu = 0.04224678
    Vu = 4560.604
  d = 0.8*h = 320.00
  Nu = 5974.983
  Ag = 160000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 251327.412
  where:
  Vs1 = 251327.412 is calculated for jacket, with:
    d = 320.00
    Av = 157079.633
    fy = 500.00
    s = 100.00
  Vs1 is multiplied by   Col1 = 1.00
    s/d = 0.3125
  Vs2 = 0.00 is calculated for core, with:
    d = 160.00
    Av = 100530.965
    fy = 400.00
    s = 250.00
  Vs2 is multiplied by   Col2 = 0.00
    s/d = 1.5625
  Vf ((11-3)-(11.4), ACI 440) = 188111.148
    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 = 1.016
  dfv = d (figure 11.2, ACI 440) = 357.00
  ffe ((11-5), ACI 440) = 259.312
    Ef = 64828.00
     fe = 0.004, from (11.6a), ACI 440
       with   fu = 0.01
  From (11-11), ACI 440: Vs + Vf <= 405571.497
    bw = 400.00

----
displacement_ductility_demand is calculated as   / y

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

From analysis, chord rotation   = 0.00012046
 y = (My*Ls/3)/Eleff = 0.00071043 ((4.29),Biskinis Phd))
  My = 1.2106E+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 = 1.7040E+013
    factor = 0.30
      Ag = 160000.00
      Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 29.75
      N = 5974.983
    Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.6801E+013

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7 -
----
 y = Min(y_ten, y_com)
 y_ten = 5.7839617E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 296.8901
    d = 357.00
     y = 0.28109392
    A = 0.01888489
    B = 0.01064175
     with pt = 0.00796398
        pc = 0.00796398
        pv = 0.00281599
        N = 5974.983
        b = 400.00
         " = 0.12044818
 y_comp = 2.3130538E-005
 with fc* (12.3, (ACI 440)) = 34.65043
    fc = 33.00
    fl = 0.93147527
    b = 400.00
    h = 400.00
    Ag = 160000.00
    From (12.9), ACI 440: ka = 0.56518315
        g = pt + pc + pv = 0.01874396
        rc = 40.00
        Ae/Ac = 0.56518315
        Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
     effective strain from (12.5) and (12.12), efe = 0.004
      fu = 0.01
     Ef = 64828.00
    Ec = 26999.444
     y = 0.27975148
    A = 0.01865339
    B = 0.01050082
     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 JC1 of floor 1
At local axis: 2
Integration Section: (b)

Calculation No. 6

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 JC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcjrs

Constant Properties

Knowledge Factor,   = 0.85
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 = 555.5556
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.4444
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556
##
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.13212
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups 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
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
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 = -1.8468314E-031
EDGE -B-
Shear Force, Vb = 1.8468314E-031
BOTH EDGES
Axial Force, F = -5976.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
       -Tension: Aslt = 0.00
    -Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
       -Tension: Asl,ten = 1137.257
     -Compression: Asl,com = 1137.257
        -Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.18171192
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 115036.425
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.7255E+008
   Mu1+ = 1.7255E+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- = 1.7255E+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-) = 1.7255E+008
   Mu2+ = 1.7255E+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- = 1.7255E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
   u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
   b = 400.00
   d = 357.00
   d' = 43.00
   v = 0.00126831
      N = 5976.808
   fc = 33.00
      co (5A.5, TBDY) = 0.002

Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
   The Shear_factor is considered equal to 1 (pure moment strength)
   From (5.4b), TBDY: cu = 0.01608084
     we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.09892348
   where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
   ----
   fx = 0.07683125
    af = 0.57333333
       b = 400.00
       h = 400.00
    From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
       bw = 400.00
    effective stress from (A.35), ff,e = 870.5244
   ----
   fy = 0.07683125
    af = 0.57333333
       b = 400.00
       h = 400.00
    From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
       bw = 400.00
    effective stress from (A.35), ff,e = 870.5244

   R = 40.00
   Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
   fu,f = 1055.00
   Ef = 64828.00
    u,f = 0.015
   ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
      ase1 = 0.24250288
         bo_1 = 340.00
         ho_1 = 340.00
          bi2_1 = 462400.00
      ase2 = Max(ase1,ase2) = 0.24250288
         bo_2 = 192.00
         ho_2 = 192.00
          bi2_2 = 147456.00
    psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
   ----
   psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
      ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
         Ash1 = Astir_1*ns_1 = 157.0796
            No stirups, ns_1 = 2.00
         h1 = 400.00
      ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
         Ash2 = Astir_2*ns_2 = 100.531
            No stirups, ns_2 = 2.00
         h2 = 200.00
   ----
   psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
      ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
         Ash1 = Astir_1*ns_1 = 157.0796
            No stirups, ns_1 = 2.00
         h1 = 400.00
      ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
         Ash2 = Astir_2*ns_2 = 100.531
            No stirups, ns_2 = 2.00
         h2 = 200.00

      Asec = 160000.00
      s1 = 100.00
      s2 = 250.00
    fywe1 = 694.4444
    fywe2 = 555.5556
    fce = 33.00
   From ((5.A5), TBDY), TBDY: cc = 0.00332119
      c = confinement factor = 1.13212
  y1 = 0.00140044

sh1 = 0.0044814
ft1 = 441.538
fy1 = 367.9484
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 = 367.9484
   with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 441.538
fy2 = 367.9484
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 = 367.9484
   with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.813
fyv = 389.0108
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 = 389.0108
   with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
cc (5A.5, TBDY) = 0.00332119
  c = confinement factor = 1.13212
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.19835408

Mu = MRc (4.14) = 1.7255E+008
  u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
    N = 5976.808
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.01608084
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx,   fy) = 0.09892348
    where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----
      fx = 0.07683125
      af = 0.57333333
        b = 400.00
        h = 400.00
     From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
       bw = 400.00
     effective stress from (A.35), ff,e = 870.5244
    ----
      fy = 0.07683125
      af = 0.57333333
        b = 400.00
        h = 400.00
     From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
       bw = 400.00
     effective stress from (A.35), ff,e = 870.5244

      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
      fu,f = 1055.00
      Ef = 64828.00
      u,f = 0.015
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
        ase1 = 0.24250288
          bo_1 = 340.00
          ho_1 = 340.00
           bi2_1 = 462400.00
        ase2 = Max(ase1,ase2) = 0.24250288
          bo_2 = 192.00
          ho_2 = 192.00
           bi2_2 = 147456.00
      psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
     ----
      psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
        ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
          Ash1 = Astir_1*ns_1 = 157.0796

```
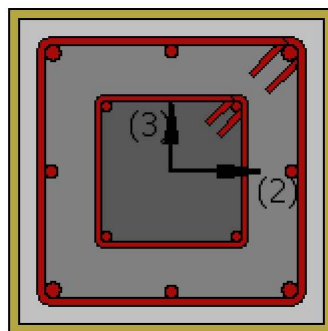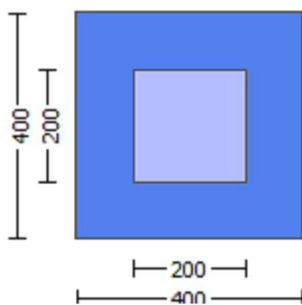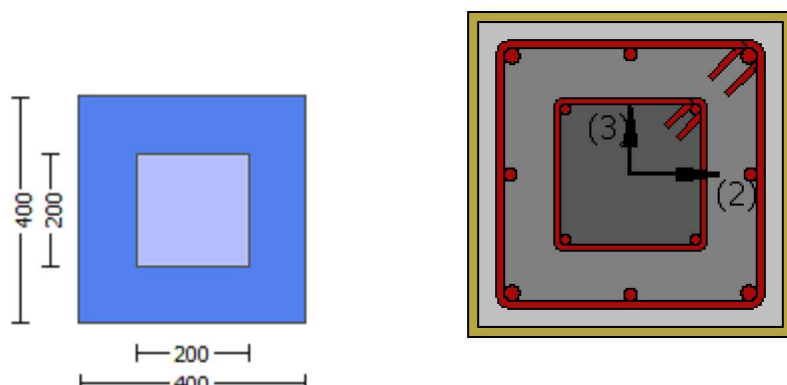                    No stirups, ns_1 = 2.00
                h1 = 400.00
            ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
                Ash2 = Astir_2*ns_2 = 100.531
                    No stirups, ns_2 = 2.00
                h2 = 200.00
        --------------------------------------------------------------------
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
            ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
                Ash1 = Astir_1*ns_1 = 157.0796
                    No stirups, ns_1 = 2.00
                h1 = 400.00
            ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
                Ash2 = Astir_2*ns_2 = 100.531
                    No stirups, ns_2 = 2.00
                h2 = 200.00
        --------------------------------------------------------------------
            Asec = 160000.00
            s1 = 100.00
            s2 = 250.00
          fywe1 = 694.4444
          fywe2 = 555.5556
          fce  = 33.00
     From ((5.A5), TBDY), TBDY:  cc = 0.00332119
          c  = confinement factor = 1.13212
   y1 = 0.00140044
  sh1 = 0.0044814
 ft1 = 441.538
 fy1 = 367.9484
  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 = 367.9484
       with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
   y2 = 0.00140044
  sh2 = 0.0044814
 ft2 = 441.538
 fy2 = 367.9484
  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 = 367.9484
       with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
   yv = 0.00140044
  shv = 0.0044814
 ftv = 466.813
 fyv = 389.0108
  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 = 389.0108
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
cc (5A.5, TBDY) = 0.00332119
c = confinement factor = 1.13212
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
u = su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.01608084
we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.09892348
where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----
fx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----
fy = 0.07683125

```
       af = 0.57333333
         b = 400.00
         h = 400.00
      From EC8 A 4.4.3(6), pf = 2tf/bw = 0.00508
         bw = 400.00
      effective stress from (A.35), ff,e = 870.5244
  --------------------------------------------------------------------
      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
      fu,f = 1055.00
      Ef = 64828.00
       u,f = 0.015
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
         ase1 = 0.24250288
            bo_1 = 340.00
            ho_1 = 340.00
             bi2_1 = 462400.00
         ase2 = Max(ase1,ase2) = 0.24250288
            bo_2 = 192.00
            ho_2 = 192.00
             bi2_2 = 147456.00
      psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
  --------------------------------------------------------------
      psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
         ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
            Ash1 = Astir_1*ns_1 = 157.0796
               No stirups, ns_1 = 2.00
            h1 = 400.00
         ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
            Ash2 = Astir_2*ns_2 = 100.531
               No stirups, ns_2 = 2.00
            h2 = 200.00
  --------------------------------------------------------------
      psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
         ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
            Ash1 = Astir_1*ns_1 = 157.0796
               No stirups, ns_1 = 2.00
            h1 = 400.00
         ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
            Ash2 = Astir_2*ns_2 = 100.531
               No stirups, ns_2 = 2.00
            h2 = 200.00
  --------------------------------------------------------------
         Asec = 160000.00
         s1 = 100.00
         s2 = 250.00
      fywe1 = 694.4444
      fywe2 = 555.5556
      fce = 33.00
   From ((5.A5), TBDY), TBDY:  cc = 0.00332119
       c = confinement factor = 1.13212
  y1 = 0.00140044
 sh1 = 0.0044814
ft1 = 441.538
fy1 = 367.9484
 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 = 367.9484
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
```

y2 = 0.00140044
  sh2 = 0.0044814
 ft2 = 441.538
 fy2 = 367.9484
  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 = 367.9484
      with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00140044
  shv = 0.0044814
 ftv = 466.813
 fyv = 389.0108
  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 = 389.0108
      with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
    2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
    v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
  b = 340.00
  d = 327.00
  d' = 13.00
  fcc (5A.2, TBDY) = 37.35991
   cc (5A.5, TBDY) = 0.00332119
      c = confinement factor = 1.13212
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
    2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
    v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
  u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

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

```
   u = 1.7890363E-005
 Mu = 1.7255E+008
 ------------------------------------------------------------------------------
 with full section properties:
   b = 400.00
   d = 357.00
   d' = 43.00
   v = 0.00126831
     N = 5976.808
   fc = 33.00
    co (5A.5, TBDY) = 0.002
   Final value of  cu:  cu* = shear_factor * Max( cu, cc) = 0.01608084
      The Shear_factor is considered equal to 1 (pure moment strength)
      From (5.4b), TBDY:  cu = 0.01608084
        we ((5.4c), TBDY) = ase*  sh,min*fywe/fce+Min(  fx,   fy) = 0.09892348
      where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
      ------------------------------------------------------------------
        fx = 0.07683125
        af = 0.57333333
           b = 400.00
           h = 400.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
           bw = 400.00
        effective stress from (A.35), ff,e = 870.5244
      ------------------------------------------------------------------
        fy = 0.07683125
        af = 0.57333333
           b = 400.00
           h = 400.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
           bw = 400.00
        effective stress from (A.35), ff,e = 870.5244
      ------------------------------------------------------------------
        R = 40.00
        Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
        fu,f = 1055.00
        Ef = 64828.00
         u,f = 0.015
        ase ((5.4d), TBDY) = (ase1*Aext+ ase2*Aint)/Asec = 0.24250288
           ase1 = 0.24250288
              bo_1 = 340.00
              ho_1 = 340.00
               bi2_1 = 462400.00
        ase2 = Max(ase1,ase2) = 0.24250288
              bo_2 = 192.00
              ho_2 = 192.00
               bi2_2 = 147456.00
        psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
      ------------------------------------------------------------------
        psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
           ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
              Ash1 = Astir_1*ns_1 = 157.0796
                 No stirups, ns_1 = 2.00
              h1 = 400.00
           ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
              Ash2 = Astir_2*ns_2 = 100.531
                 No stirups, ns_2 = 2.00
              h2 = 200.00
      ------------------------------------------------------------------
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
           ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
              Ash1 = Astir_1*ns_1 = 157.0796
                 No stirups, ns_1 = 2.00
              h1 = 400.00
           ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
              Ash2 = Astir_2*ns_2 = 100.531
                 No stirups, ns_2 = 2.00
```

```
          h2 = 200.00
     ------------------------------------------------------------------
          Asec = 160000.00
           s1 = 100.00
           s2 = 250.00
        fywe1 = 694.4444
        fywe2 = 555.5556
          fce = 33.00
     From ((5.A5), TBDY):  cc = 0.00332119
          c  = confinement factor = 1.13212
    y1 = 0.00140044
   sh1 = 0.0044814
  ft1 = 441.538
  fy1 = 367.9484
   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 = 367.9484
       with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
    y2 = 0.00140044
   sh2 = 0.0044814
  ft2 = 441.538
  fy2 = 367.9484
   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 = 367.9484
       with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
    yv = 0.00140044
   shv = 0.0044814
  ftv = 466.813
  fyv = 389.0108
   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 = 389.0108
       with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
     2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
     v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
 and confined core properties:
   b = 340.00
   d = 327.00
   d' = 13.00
  fcc (5A.2, TBDY) = 37.35991
```

cc (5A.5, TBDY) = 0.00332119
   c = confinement factor = 1.13212
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
  2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
  v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
 u = su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 633070.334

Calculation of Shear Strength at edge 1, Vr1 = 633070.334
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 633070.334
  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 = 29.75, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
   Mu = 8.4878329E-012
   Vu = 1.8468314E-031
  d = 0.8*h = 320.00
  Nu = 5976.808
  Ag = 160000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279252.68
  where:
  Vs1 = 279252.68 is calculated for jacket, with:
   d = 320.00
   Av = 157079.633
   fy = 555.5556
   s = 100.00
  Vs1 is multiplied by Col1 = 1.00
   s/d = 0.3125
  Vs2 = 0.00 is calculated for core, with:
   d = 160.00
   Av = 100530.965
   fy = 444.4444
   s = 250.00
  Vs2 is multiplied by Col2 = 0.00
   s/d = 1.5625
  Vf ((11-3)-(11.4), ACI 440) = 188111.148
   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 = 1.016

```
    dfv = d (figure 11.2, ACI 440) = 357.00
    ffe ((11-5), ACI 440) = 259.312
       Ef = 64828.00
        fe = 0.004, from (11.6a), ACI 440
          with  fu = 0.01
     From (11-11), ACI 440: Vs + Vf <= 463788.751
       bw = 400.00
------------------------------------------------------------
-------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 633070.334
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
   VCol0 = 633070.334
   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 = 29.75, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
   M/Vd = 2.00
      Mu = 8.4878329E-012
      Vu = 1.8468314E-031
   d = 0.8*h = 320.00
   Nu = 5976.808
   Ag = 160000.00
   From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279252.68
   where:
   Vs1 = 279252.68 is calculated for jacket, with:
     d = 320.00
     Av = 157079.633
     fy = 555.5556
     s = 100.00
   Vs1 is multiplied by   Col1 = 1.00
     s/d = 0.3125
   Vs2 = 0.00 is calculated for core, with:
     d = 160.00
     Av = 100530.965
     fy = 444.4444
     s = 250.00
   Vs2 is multiplied by   Col2 = 0.00
     s/d = 1.5625
   Vf ((11-3)-(11.4), ACI 440) = 188111.148
     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 = 1.016
   dfv = d (figure 11.2, ACI 440) = 357.00
   ffe ((11-5), ACI 440) = 259.312
      Ef = 64828.00
       fe = 0.004, from (11.6a), ACI 440
         with  fu = 0.01
     From (11-11), ACI 440: Vs + Vf <= 463788.751
       bw = 400.00
------------------------------------------------------------
-------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 3

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

Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjrs

Constant Properties

Knowledge Factor, = 0.85
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 = 555.5556
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.4444
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556
##
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.13212
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups 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
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
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 = 3.2548216E-032
EDGE -B-
Shear Force, Vb = -3.2548216E-032
BOTH EDGES
Axial Force, F = -5976.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: Asl,ten = 1137.257
    -Compression: Asl,com = 1137.257
        -Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.18171192
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 115036.425
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.7255E+008
   Mu1+ = 1.7255E+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- = 1.7255E+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-) = 1.7255E+008
   Mu2+ = 1.7255E+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- = 1.7255E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
  ϕ_u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.001 26831
     N = 5976.808
  fc = 33.00
   ε_{co} (5A.5, TBDY) = 0.002
  Final value of ε_{cu}: ε_{cu}^* = shear_factor * Max(ε_{cu}, ε_{cc}) = 0.01608084
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: ε_{cu} = 0.01608084
      ω_{we} ((5.4c), TBDY) = α_{se}* $\rho_{sh,min}$*fywe/fce+Min(ω_{fx}, ω_{fy}) = 0.09892348
    where ω_f = α_f*ρ_f*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

      ω_{fx} = 0.07683125
      α_f = 0.57333333
         b = 400.00
         h = 400.00
      From EC8 A 4.4.3(6), ρ_f = 2tf/bw = 0.00508
         bw = 400.00
      effective stress from (A.35), ff,e = 870.5244

      ω_{fy} = 0.07683125
      α_f = 0.57333333
         b = 400.00
         h = 400.00
      From EC8 A 4.4.3(6), ρ_f = 2tf/bw = 0.00508
         bw = 400.00
      effective stress from (A.35), ff,e = 870.5244

      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
      fu,f = 1055.00
      Ef = 64828.00
       $\varepsilon_{u,f}$ = 0.015
      α_{se} ((5.4d), TBDY) = (α_{se1}*Aext+α_{se2}*Aint)/Asec = 0.24250288

```
        ase1 = 0.24250288
            bo_1 = 340.00
            ho_1 = 340.00
             bi2_1 = 462400.00
        ase2 = Max(ase1,ase2) = 0.24250288
            bo_2 = 192.00
            ho_2 = 192.00
             bi2_2 = 147456.00
        psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
    ------------------------------------------------------------------
        psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
          ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
            Ash1 = Astir_1*ns_1 = 157.0796
               No stirups, ns_1 = 2.00
            h1 = 400.00
          ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
            Ash2 = Astir_2*ns_2 = 100.531
               No stirups, ns_2 = 2.00
            h2 = 200.00
    ------------------------------------------------------------------
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
          ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
            Ash1 = Astir_1*ns_1 = 157.0796
               No stirups, ns_1 = 2.00
            h1 = 400.00
          ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
            Ash2 = Astir_2*ns_2 = 100.531
               No stirups, ns_2 = 2.00
            h2 = 200.00
    ------------------------------------------------------------------
          Asec = 160000.00
          s1 = 100.00
          s2 = 250.00
       fywe1 = 694.4444
       fywe2 = 555.5556
       fce  = 33.00
     From ((5.A5), TBDY), TBDY:  cc = 0.00332119
         c  = confinement factor = 1.13212
  y1 = 0.00140044
  sh1 = 0.0044814
 ft1 = 441.538
 fy1 = 367.9484
  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 = 367.9484
     with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.00140044
  sh2 = 0.0044814
 ft2 = 441.538
 fy2 = 367.9484
  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 = 367.9484
   with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00140044
  shv = 0.0044814
ftv = 466.813
fyv = 389.0108
 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 = 389.0108
   with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
  2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
  v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
  b = 340.00
  d = 327.00
  d' = 13.00
  fcc (5A.2, TBDY) = 37.35991
  cc (5A.5, TBDY) = 0.00332119
   c = confinement factor = 1.13212
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
  2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
  v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
 u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
 u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
   N = 5976.808
  fc = 33.00
  co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
   The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: cu = 0.01608084
   we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.09892348
where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----
  fx = 0.07683125
   af = 0.57333333
     b = 400.00
     h = 400.00
  From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
    bw = 400.00
  effective stress from (A.35), ff,e = 870.5244
----
  fy = 0.07683125
   af = 0.57333333
     b = 400.00
     h = 400.00
  From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
    bw = 400.00
  effective stress from (A.35), ff,e = 870.5244

  R = 40.00
  Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
  fu,f = 1055.00
  Ef = 64828.00
   u,f = 0.015
  ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
    ase1 = 0.24250288
      bo_1 = 340.00
      ho_1 = 340.00
       bi2_1 = 462400.00
    ase2 = Max(ase1,ase2) = 0.24250288
      bo_2 = 192.00
      ho_2 = 192.00
       bi2_2 = 147456.00
  psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
----
  psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
    ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
      Ash1 = Astir_1*ns_1 = 157.0796
       No stirups, ns_1 = 2.00
      h1 = 400.00
    ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
      Ash2 = Astir_2*ns_2 = 100.531
       No stirups, ns_2 = 2.00
      h2 = 200.00
----
  psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
    ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
      Ash1 = Astir_1*ns_1 = 157.0796
       No stirups, ns_1 = 2.00
      h1 = 400.00
    ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
      Ash2 = Astir_2*ns_2 = 100.531
       No stirups, ns_2 = 2.00
      h2 = 200.00

    Asec = 160000.00
    s1 = 100.00
    s2 = 250.00
  fywe1 = 694.4444
  fywe2 = 555.5556
  fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00332119
  c = confinement factor = 1.13212
y1 = 0.00140044
sh1 = 0.00448141
ft1 = 441.538

fy1 = 367.9484
 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 = 367.9484
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
 y2 = 0.00140044
 sh2 = 0.0044814
ft2 = 441.538
fy2 = 367.9484
 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 = 367.9484
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
 yv = 0.00140044
 shv = 0.0044814
ftv = 466.813
fyv = 389.0108
 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 = 389.0108
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
  2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
  v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
  b = 340.00
  d = 327.00
  d' = 13.00
  fcc (5A.2, TBDY) = 37.35991
   cc (5A.5, TBDY) = 0.00332119
     c = confinement factor = 1.13212
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
   2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
   v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
 u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
  u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
    N = 5976.808
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: cu = 0.01608084
       we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.09892348
     where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
     ----
       fx = 0.07683125
       af = 0.57333333
          b = 400.00
          h = 400.00
        From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
          bw = 400.00
        effective stress from (A.35), ff,e = 870.5244
     ----
       fy = 0.07683125
       af = 0.57333333
          b = 400.00
          h = 400.00
        From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
          bw = 400.00
        effective stress from (A.35), ff,e = 870.5244

       R = 40.00
       Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
       fu,f = 1055.00
       Ef = 64828.00
        u,f = 0.015
       ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
          ase1 = 0.24250288
             bo_1 = 340.00
             ho_1 = 340.00
               bi2_1 = 462400.00
          ase2 = Max(ase1,ase2) = 0.24250288
             bo_2 = 192.00
             ho_2 = 192.00
               bi2_2 = 147456.00
       psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
     ----
       psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
          ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
             Ash1 = Astir_1*ns_1 = 157.0796
                No stirups, ns_1 = 2.00
             h1 = 400.00

```
            ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
                Ash2 = Astir_2*ns_2 = 100.531
                    No stirups, ns_2 = 2.00
                h2 = 200.00
        ----------------------------------------------------------------
            psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
                ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
                    Ash1 = Astir_1*ns_1 = 157.0796
                        No stirups, ns_1 = 2.00
                    h1 = 400.00
                ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
                    Ash2 = Astir_2*ns_2 = 100.531
                        No stirups, ns_2 = 2.00
                    h2 = 200.00
        ----------------------------------------------------------------
            Asec = 160000.00
            s1 = 100.00
            s2 = 250.00
        fywe1 = 694.4444
        fywe2 = 555.5556
        fce  = 33.00
    From ((5.A5), TBDY), TBDY:  cc = 0.00332119
        c  = confinement factor = 1.13212
 y1 = 0.00140044
 sh1 = 0.0044814
ft1 = 441.538
fy1 = 367.9484
 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 = 367.9484
        with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
 y2 = 0.00140044
 sh2 = 0.0044814
ft2 = 441.538
fy2 = 367.9484
 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 = 367.9484
        with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
 yv = 0.00140044
 shv = 0.0044814
ftv = 466.813
fyv = 389.0108
 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 = 389.0108
   with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
  2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
  v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
  b = 340.00
  d = 327.00
  d' = 13.00
  fcc (5A.2, TBDY) = 37.35991
   cc (5A.5, TBDY) = 0.00332119
      c = confinement factor = 1.13212
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
    2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
    v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
 u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
 u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
    N = 5976.808
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.01608084
     we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx,   fy) = 0.09892348
    where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
      ----
      fx = 0.07683125
       af = 0.57333333
         b = 400.00
         h = 400.00
       From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
         bw = 400.00
       effective stress from (A.35), ff,e = 870.5244
      ----
      fy = 0.07683125
       af = 0.57333333
         b = 400.00

```
        h = 400.00
      From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
         bw = 400.00
      effective stress from (A.35), ff,e = 870.5244
  ----------------------------------------------------------------
      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
      fu,f = 1055.00
      Ef = 64828.00
       u,f = 0.015
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
         ase1 = 0.24250288
            bo_1 = 340.00
            ho_1 = 340.00
             bi2_1 = 462400.00
         ase2 = Max(ase1,ase2) = 0.24250288
            bo_2 = 192.00
            ho_2 = 192.00
             bi2_2 = 147456.00
      psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
  ----------------------------------------------------------------
      psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
         ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
            Ash1 = Astir_1*ns_1 = 157.0796
               No stirups, ns_1 = 2.00
            h1 = 400.00
         ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
            Ash2 = Astir_2*ns_2 = 100.531
               No stirups, ns_2 = 2.00
            h2 = 200.00
  ----------------------------------------------------------------
      psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
         ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
            Ash1 = Astir_1*ns_1 = 157.0796
               No stirups, ns_1 = 2.00
            h1 = 400.00
         ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
            Ash2 = Astir_2*ns_2 = 100.531
               No stirups, ns_2 = 2.00
            h2 = 200.00
  ----------------------------------------------------------------
         Asec = 160000.00
         s1 = 100.00
         s2 = 250.00
      fywe1 = 694.4444
      fywe2 = 555.5556
      fce  = 33.00
   From ((5.A5), TBDY), TBDY:  cc = 0.00332119
        c = confinement factor = 1.13212
  y1 = 0.00140044
 sh1 = 0.0044814
ft1 = 441.538
fy1 = 367.9484
 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 = 367.9484
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
 y2 = 0.00140044
sh2 = 0.0044814
```

ft2 = 441.538
    fy2 = 367.9484
     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 = 367.9484
         with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
     yv = 0.00140044
     shv = 0.0044814
    ftv = 466.813
    fyv = 389.0108
     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 = 389.0108
         with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
      1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
      2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
      v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
   b = 340.00
   d = 327.00
   d' = 13.00
   fcc (5A.2, TBDY) = 37.35991
    cc (5A.5, TBDY) = 0.00332119
       c = confinement factor = 1.13212
      1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
      2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
      v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
  u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 633070.334

Calculation of Shear Strength at edge 1, Vr1 = 633070.334
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 633070.334
  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 = 29.75, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
  Mu = 1.4989884E-012
  Vu = 3.2548216E-032
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279252.68
where:
Vs1 = 279252.68 is calculated for jacket, with:
  d = 320.00
  Av = 157079.633
  fy = 555.5556
  s = 100.00
Vs1 is multiplied by Col1 = 1.00
  s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
  d = 160.00
  Av = 100530.965
  fy = 444.4444
  s = 250.00
Vs2 is multiplied by Col2 = 0.00
  s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
  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 = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
  Ef = 64828.00
   fe = 0.004, from (11.6a), ACI 440
    with fu = 0.01
From (11-11), ACI 440: Vs + Vf <= 463788.751
  bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 633070.334
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 633070.334
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 = 29.75, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
  Mu = 1.4989884E-012
  Vu = 3.2548216E-032
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279252.68
where:

Vs1 = 279252.68 is calculated for jacket, with:
    d = 320.00
    Av = 157079.633
    fy = 555.5556
    s = 100.00
  Vs1 is multiplied by   Col1 = 1.00
    s/d = 0.3125
  Vs2 = 0.00 is calculated for core, with:
    d = 160.00
    Av = 100530.965
    fy = 444.4444
    s = 250.00
  Vs2 is multiplied by   Col2 = 0.00
    s/d = 1.5625
  Vf ((11-3)-(11.4), ACI 440) = 188111.148
    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 = 1.016
  dfv = d (figure 11.2, ACI 440) = 357.00
  ffe ((11-5), ACI 440) = 259.312
    Ef = 64828.00
     fe = 0.004, from (11.6a), ACI 440
       with   fu = 0.01
  From (11-11), ACI 440: Vs + Vf <= 463788.751
    bw = 400.00

End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 2
Integration Section: (b)
Section Type: rcjrs

Constant Properties

Knowledge Factor,   = 0.85
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 = 555.5556
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member

Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups 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
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
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 = -1.1352078E-010
Shear Force, V2 = 4560.604
Shear Force, V3 = -9.4294951E-014
Axial Force, F = -5974.983
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1137.257
     -Compression: Asl,com = 1137.257
        -Middle: Asl,mid = 402.1239
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,jacket = 829.3805
     -Compression: Asl,com,jacket = 829.3805
        -Middle: Asl,mid,jacket = 402.1239
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,core = 307.8761
     -Compression: Asl,com,core = 307.8761
        -Middle: Asl,mid,core = 0.00
Mean Diameter of Tension Reinforcement, DbL = 16.80

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $\theta u,R = \quad * \theta u = 0.00301933$
 $\theta u = \theta y + \theta p = 0.00355215$

 - Calculation of θy -

 $\theta y = (My*Ls/3)/EIeff = 0.00355215$ ((4.29),Biskinis Phd))
 My = 1.2106E+008
 Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
 From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7040E+013
    factor = 0.30
      Ag = 160000.00
      Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 29.75
      N = 5974.983
    Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.6801E+013

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 = 5.7839617E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 296.8901
    d = 357.00
    y = 0.28109392
    A = 0.01888489
    B = 0.01064175
    with pt = 0.00680079
        pc = 0.00796398
        pv = 0.00281599
        N = 5974.983
        b = 400.00
          " = 0.12044818
 y_comp = 2.3130538E-005
with fc* (12.3, (ACI 440)) = 34.65043
    fc = 33.00
    fl = 0.93147527
    b = 400.00
    h = 400.00
    Ag = 160000.00
    From (12.9), ACI 440: ka = 0.56518315
        g = pt + pc + pv = 0.01874396
      rc = 40.00
      Ae/Ac = 0.56518315
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
    effective strain from (12.5) and (12.12), efe = 0.004
      fu = 0.01
    Ef = 64828.00
    Ec = 26999.444
     y = 0.27975148
     A = 0.01865339
     B = 0.01050082
     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 = 0.18171192
   d = d_external = 357.00
   s = s_external = 0.00
    t =   s1 +   s2 + 2*tf/bw*(ffe/fs) = 0.00680079
  jacket:   s1 = Av1*h1/(s1*Ag) = 0.00392699
        Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
        h1 = 400.00
        s1 = 100.00
   core:    s2 = Av2*h2/(s2*Ag) = 0.00050265
        Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
        h2 = 200.00
        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 = 5974.983
    Ag = 160000.00
    f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 29.75
    fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein =
529.9948
    fytE = (fy_ext_Trans_Reinf*Area_ext_Trans_Reinf+fy_int_Trans_Reinf*Area_int_Trans_Reinf)/Area_Tot_Trans_Rein =
```

542.9472
pl = Area_Tot_Long_Rein/(b*d) = 0.01874396
  b = 400.00
  d = 357.00
   f'cE = 29.75

End Of Calculation of Chord Rotation Capacity for element: column JC1 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 JC1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rcjrs

Constant Properties

Knowledge Factor,   = 0.85
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
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of y for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, 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 = 555.5556
Existing Column
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.4444
##
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups 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
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
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 = -1.6937287E-010
Shear Force, Va = 9.4294951E-014
EDGE -B-
Bending Moment, Mb = -1.1352078E-010
Shear Force, Vb = -9.4294951E-014
BOTH EDGES
Axial Force, F = -5974.983
Longitudinal Reinforcement Area Distribution (in 2 divisions)
       -Tension: Aslt = 0.00
     -Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
       -Tension: Asl,ten = 1137.257
     -Compression: Asl,com = 1137.257
         -Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL,ten = 16.80

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR =   *Vn = 475023.475
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 558851.147
   VCol = 558851.147
   knl = 1.00

displacement_ductility_demand = 0.00

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 = 22.75, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
   M/Vd = 2.00
      Mu = 1.1352078E-010
      Vu = 9.4294951E-014
   d = 0.8*h = 320.00
   Nu = 5974.983
   Ag = 160000.00
   From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 251327.412
   where:
   Vs1 = 251327.412 is calculated for jacket, with:
      d = 320.00
      Av = 157079.633
      fy = 500.00
      s = 100.00
   Vs1 is multiplied by   Col1 = 1.00
      s/d = 0.3125
   Vs2 = 0.00 is calculated for core, with:
      d = 160.00
      Av = 100530.965
      fy = 400.00
      s = 250.00
   Vs2 is multiplied by   Col2 = 0.00
      s/d = 1.5625
   Vf ((11-3)-(11.4), ACI 440) = 188111.148
      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 = 1.016
   dfv = d (figure 11.2, ACI 440) = 357.00
   ffe ((11-5), ACI 440) = 259.312
      Ef = 64828.00
       fe = 0.004, from (11.6a), ACI 440
         with fu = 0.01
   From (11-11), ACI 440: Vs + Vf <= 405571.497
      bw = 400.00

----
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   = 1.0792184E-022
 y = (My*Ls/3)/EIeff = 0.00355215 ((4.29),Biskinis Phd))
   My = 1.2106E+008
   Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
   From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7040E+013
      factor = 0.30
         Ag = 160000.00
         Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 29.75
         N = 5974.983
      Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.6801E+013

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7 -

----

  y = Min(y_ten, y_com)
  y_ten = 5.7839617E-006
  with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 296.8901
    d = 357.00
     y = 0.28109392
    A = 0.01888489
    B = 0.01064175
     with pt = 0.00796398
        pc = 0.00796398
        pv = 0.00281599
        N = 5974.983
        b = 400.00
        " = 0.12044818
  y_comp = 2.3130538E-005
 with fc* (12.3, (ACI 440)) = 34.65043
    fc = 33.00
    fl = 0.93147527
    b = 400.00
    h = 400.00
    Ag = 160000.00
    From (12.9), ACI 440: ka = 0.56518315
        g = pt + pc + pv = 0.01874396
      rc = 40.00
      Ae/Ac = 0.56518315
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
     effective strain from (12.5) and (12.12), efe = 0.004
      fu = 0.01
    Ef = 64828.00
    Ec = 26999.444
     y = 0.27975148
    A = 0.01865339
    B = 0.01050082
     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 JC1 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 JC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcjrs

Constant Properties

Knowledge Factor, = 0.85
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 = 555.5556
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.4444
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556
##
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.13212
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups 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
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
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 = -1.8468314E-031
EDGE -B-
Shear Force, Vb = 1.8468314E-031
BOTH EDGES
Axial Force, F = -5976.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
       -Tension: Aslt = 0.00
    -Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
       -Tension: Asl,ten = 1137.257
     -Compression: Asl,com = 1137.257
        -Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.18171192
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 115036.425
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.7255E+008
  Mu1+ = 1.7255E+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- = 1.7255E+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-) = 1.7255E+008
  Mu2+ = 1.7255E+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- = 1.7255E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
  u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
    N = 5976.808
  fc = 33.00
    co (5A.5, TBDY) = 0.002

Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
   The Shear_factor is considered equal to 1 (pure moment strength)
   From (5.4b), TBDY: cu = 0.01608084
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.09892348
   where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
   ----
   fx = 0.07683125
     af = 0.57333333
        b = 400.00
        h = 400.00
     From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
        bw = 400.00
     effective stress from (A.35), ff,e = 870.5244
   ----
   fy = 0.07683125
     af = 0.57333333
        b = 400.00
        h = 400.00
     From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
        bw = 400.00
     effective stress from (A.35), ff,e = 870.5244

   R = 40.00
   Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
   fu,f = 1055.00
   Ef = 64828.00
    u,f = 0.015
   ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
      ase1 = 0.24250288
         bo_1 = 340.00
         ho_1 = 340.00
          bi2_1 = 462400.00
      ase2 = Max(ase1,ase2) = 0.24250288
         bo_2 = 192.00
         ho_2 = 192.00
          bi2_2 = 147456.00
   psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
   ----
   psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
      ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
         Ash1 = Astir_1*ns_1 = 157.0796
            No stirups, ns_1 = 2.00
         h1 = 400.00
      ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
         Ash2 = Astir_2*ns_2 = 100.531
            No stirups, ns_2 = 2.00
         h2 = 200.00
   ----
   psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
      ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
         Ash1 = Astir_1*ns_1 = 157.0796
            No stirups, ns_1 = 2.00
         h1 = 400.00
      ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
         Ash2 = Astir_2*ns_2 = 100.531
            No stirups, ns_2 = 2.00
         h2 = 200.00

         Asec = 160000.00
         s1 = 100.00
         s2 = 250.00
      fywe1 = 694.4444
      fywe2 = 555.5556
      fce = 33.00
   From ((5.A5), TBDY), TBDY: cc = 0.00332119
        c = confinement factor = 1.13212
   y1 = 0.00140044

sh1 = 0.0044814
ft1 = 441.538
fy1 = 367.9484
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 = 367.9484
  with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 441.538
fy2 = 367.9484
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 = 367.9484
  with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.813
fyv = 389.0108
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 = 389.0108
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
cc (5A.5, TBDY) = 0.00332119
  c = confinement factor = 1.13212
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.19835408

Mu = MRc (4.14) = 1.7255E+008
  u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
    N = 5976.808
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of   cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: cu = 0.01608084
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx,   fy) = 0.09892348
     where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
     ----
      fx = 0.07683125
      af = 0.57333333
         b = 400.00
         h = 400.00
       From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
         bw = 400.00
       effective stress from (A.35), ff,e = 870.5244
     ----
      fy = 0.07683125
      af = 0.57333333
         b = 400.00
         h = 400.00
       From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
         bw = 400.00
       effective stress from (A.35), ff,e = 870.5244

      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
      fu,f = 1055.00
      Ef = 64828.00
       u,f = 0.015
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
         ase1 = 0.24250288
            bo_1 = 340.00
            ho_1 = 340.00
             bi2_1 = 462400.00
         ase2 = Max(ase1,ase2) = 0.24250288
             bo_2 = 192.00
             ho_2 = 192.00
              bi2_2 = 147456.00
         psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
     ----
         psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
           ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
               Ash1 = Astir_1*ns_1 = 157.0796

No stirups, ns_1 = 2.00
                 h1 = 400.00
              ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
                 Ash2 = Astir_2*ns_2 = 100.531
                    No stirups, ns_2 = 2.00
                 h2 = 200.00
         ----
            psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
               ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
                 Ash1 = Astir_1*ns_1 = 157.0796
                    No stirups, ns_1 = 2.00
                 h1 = 400.00
              ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
                 Ash2 = Astir_2*ns_2 = 100.531
                    No stirups, ns_2 = 2.00
                 h2 = 200.00

            Asec = 160000.00
            s1 = 100.00
            s2 = 250.00
          fywe1 = 694.4444
          fywe2 = 555.5556
           fce = 33.00
     From ((5.A5), TBDY), TBDY: cc = 0.00332119
          c = confinement factor = 1.13212
   y1 = 0.00140044
  sh1 = 0.0044814
 ft1 = 441.538
 fy1 = 367.9484
  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 = 367.9484
      with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.00140044
  sh2 = 0.0044814
 ft2 = 441.538
 fy2 = 367.9484
  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 = 367.9484
      with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00140044
  shv = 0.0044814
 ftv = 466.813
 fyv = 389.0108
  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 = 389.0108
 with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
 2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
 v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
  b = 340.00
  d = 327.00
  d' = 13.00
  fcc (5A.2, TBDY) = 37.35991
   cc (5A.5, TBDY) = 0.00332119
     c = confinement factor = 1.13212
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
   2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
   v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
 u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
    N = 5976.808
  fc = 33.00
  co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.01608084
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx,   fy) = 0.09892348
    where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
      ----
      fx = 0.07683125
       af = 0.57333333
          b = 400.00
          h = 400.00
       From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
          bw = 400.00
       effective stress from (A.35), ff,e = 870.5244
      ----
      fy = 0.07683125

af = 0.57333333
  b = 400.00
  h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
  bw = 400.00
effective stress from (A.35), ff,e = 870.5244

R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
 u,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
  ase1 = 0.24250288
    bo_1 = 340.00
    ho_1 = 340.00
     bi2_1 = 462400.00
  ase2 = Max(ase1,ase2) = 0.24250288
    bo_2 = 192.00
    ho_2 = 192.00
     bi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
  ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
    Ash1 = Astir_1*ns_1 = 157.0796
     No stirups, ns_1 = 2.00
    h1 = 400.00
  ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
    Ash2 = Astir_2*ns_2 = 100.531
     No stirups, ns_2 = 2.00
    h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
  ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
    Ash1 = Astir_1*ns_1 = 157.0796
     No stirups, ns_1 = 2.00
    h1 = 400.00
  ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
    Ash2 = Astir_2*ns_2 = 100.531
     No stirups, ns_2 = 2.00
    h2 = 200.00

  Asec = 160000.00
  s1 = 100.00
  s2 = 250.00
fywe1 = 694.4444
fywe2 = 555.5556
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00332119
  c = confinement factor = 1.13212
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 441.538
fy1 = 367.9484
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 = 367.9484
 with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.00140044
      sh2 = 0.0044814
    ft2 = 441.538
    fy2 = 367.9484
      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 = 367.9484
          with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
      yv = 0.00140044
      shv = 0.0044814
    ftv = 466.813
    fyv = 389.0108
      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 = 389.0108
          with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
      1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
      2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
      v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
  b = 340.00
  d = 327.00
  d' = 13.00
  fcc (5A.2, TBDY) = 37.35991
    cc (5A.5, TBDY) = 0.00332119
      c = confinement factor = 1.13212
      1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
      2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
      v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
  u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

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

```
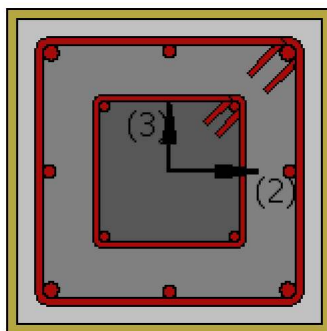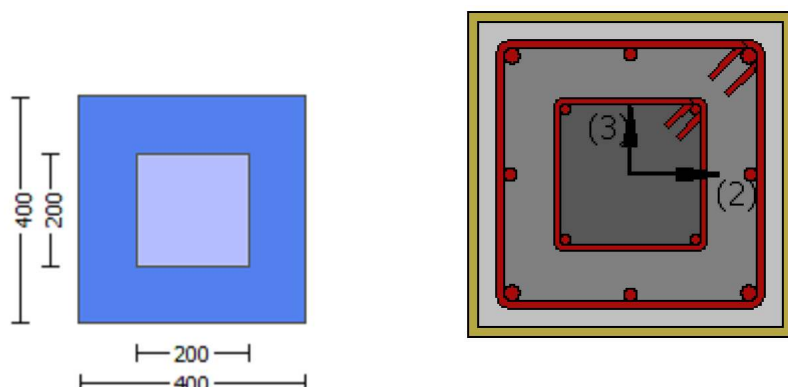  u = 1.7890363E-005
Mu = 1.7255E+008
-------------------------------------------------------------------------------
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
    N = 5976.808
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of  cu:  cu* = shear_factor * Max( cu, cc) = 0.01608084
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY:  cu = 0.01608084
        we ((5.4c), TBDY) = ase*  sh,min*fywe/fce+Min(  fx,   fy) = 0.09892348
     where    f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
     ----------------------------------------------------------------
        fx = 0.07683125
        af = 0.57333333
           b = 400.00
           h = 400.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
           bw = 400.00
        effective stress from (A.35), ff,e = 870.5244
     ----------------------------------------------------------------
        fy = 0.07683125
        af = 0.57333333
           b = 400.00
           h = 400.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
           bw = 400.00
        effective stress from (A.35), ff,e = 870.5244
     ----------------------------------------------------------------
        R = 40.00
        Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
        fu,f = 1055.00
        Ef = 64828.00
         u,f = 0.015
        ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
           ase1 = 0.24250288
              bo_1 = 340.00
              ho_1 = 340.00
               bi2_1 = 462400.00
        ase2 = Max(ase1,ase2) = 0.24250288
              bo_2 = 192.00
              ho_2 = 192.00
               bi2_2 = 147456.00
        psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
     ----------------------------------------------------------------
        psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
           ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
              Ash1 = Astir_1*ns_1 = 157.0796
                 No stirups, ns_1 = 2.00
              h1 = 400.00
           ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
              Ash2 = Astir_2*ns_2 = 100.531
                 No stirups, ns_2 = 2.00
              h2 = 200.00
     ----------------------------------------------------------------
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
           ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
              Ash1 = Astir_1*ns_1 = 157.0796
                 No stirups, ns_1 = 2.00
              h1 = 400.00
           ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
              Ash2 = Astir_2*ns_2 = 100.531
                 No stirups, ns_2 = 2.00
```

```
              h2 = 200.00
        ----------------------------------------------------------------
             Asec = 160000.00
              s1 = 100.00
              s2 = 250.00
           fywe1 = 694.4444
           fywe2 = 555.5556
            fce  = 33.00
        From ((5.A.5), TBDY),  TBDY:   cc = 0.00332119
             c  = confinement factor = 1.13212
     y1 = 0.00140044
     sh1 = 0.0044814
   ft1 = 441.538
   fy1 = 367.9484
     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 = 367.9484
         with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
     y2 = 0.00140044
     sh2 = 0.0044814
   ft2 = 441.538
   fy2 = 367.9484
     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 = 367.9484
         with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
     yv = 0.00140044
     shv = 0.0044814
   ftv = 466.813
   fyv = 389.0108
     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 = 389.0108
         with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
     2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
     v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
 and confined core properties:
   b = 340.00
   d = 327.00
   d' = 13.00
   fcc (5A.2, TBDY) = 37.35991
```

cc (5A.5, TBDY) = 0.00332119
   c = confinement factor = 1.13212
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
   2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
   v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
 u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 633070.334

Calculation of Shear Strength at edge 1, Vr1 = 633070.334
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 633070.334
  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 = 29.75, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
    Mu = 8.4878329E-012
    Vu = 1.8468314E-031
  d = 0.8*h = 320.00
  Nu = 5976.808
  Ag = 160000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279252.68
  where:
  Vs1 = 279252.68 is calculated for jacket, with:
    d = 320.00
    Av = 157079.633
    fy = 555.5556
    s = 100.00
  Vs1 is multiplied by Col1 = 1.00
    s/d = 0.3125
  Vs2 = 0.00 is calculated for core, with:
    d = 160.00
    Av = 100530.965
    fy = 444.4444
    s = 250.00
  Vs2 is multiplied by Col2 = 0.00
    s/d = 1.5625
  Vf ((11-3)-(11.4), ACI 440) = 188111.148
    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 = 1.016

dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
   Ef = 64828.00
    fe = 0.004, from (11.6a), ACI 440
     with   fu = 0.01
 From (11-11), ACI 440: Vs + Vf < = 463788.751
   bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 633070.334
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 633070.334
  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 = 29.75, but fc^0.5 < = 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
    Mu = 8.4878329E-012
    Vu = 1.8468314E-031
  d = 0.8*h = 320.00
  Nu = 5976.808
  Ag = 160000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279252.68
  where:
  Vs1 = 279252.68 is calculated for jacket, with:
   d = 320.00
   Av = 157079.633
   fy = 555.5556
   s = 100.00
  Vs1 is multiplied by   Col1 = 1.00
   s/d = 0.3125
  Vs2 = 0.00 is calculated for core, with:
   d = 160.00
   Av = 100530.965
   fy = 444.4444
   s = 250.00
  Vs2 is multiplied by   Col2 = 0.00
   s/d = 1.5625
  Vf ((11-3)-(11.4), ACI 440) = 188111.148
   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 = 1.016
  dfv = d (figure 11.2, ACI 440) = 357.00
  ffe ((11-5), ACI 440) = 259.312
    Ef = 64828.00
     fe = 0.004, from (11.6a), ACI 440
      with   fu = 0.01
  From (11-11), ACI 440: Vs + Vf < = 463788.751
   bw = 400.00

End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjrs

Constant Properties

Knowledge Factor,   = 0.85
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 = 555.5556
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.4444
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556
##
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.13212
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups 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
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
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 = 3.2548216E-032
EDGE -B-
Shear Force, Vb = -3.2548216E-032
BOTH EDGES
Axial Force, F = -5976.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
    -Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)

      -Tension: Asl,ten = 1137.257
    -Compression: Asl,com = 1137.257
      -Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.18171192
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 115036.425
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.7255E+008
  Mu1+ = 1.7255E+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- = 1.7255E+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-) = 1.7255E+008
  Mu2+ = 1.7255E+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- = 1.7255E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature ϕu according to 4.1, Biskinis/Fardis 2013:
  ϕu = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
    N = 5976.808
  fc = 33.00
  ϵco (5A.5, TBDY) = 0.002
  Final value of ϵcu: ϵcu* = shear_factor * Max(ϵcu, ϵcc) = 0.01608084
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: ϵcu = 0.01608084
      ωwe ((5.4c), TBDY) = αse*ρsh,min*fywe/fce+Min(αfx, αfy) = 0.09892348
    where αf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

      αfx = 0.07683125
      af = 0.57333333
        b = 400.00
        h = 400.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
        bw = 400.00
      effective stress from (A.35), ff,e = 870.5244

      αfy = 0.07683125
      af = 0.57333333
        b = 400.00
        h = 400.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
        bw = 400.00
      effective stress from (A.35), ff,e = 870.5244

      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
      fu,f = 1055.00
      Ef = 64828.00
      ϵu,f = 0.015
      αse ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288

```
           ase1 = 0.24250288
              bo_1 = 340.00
              ho_1 = 340.00
               bi2_1 = 462400.00
          ase2 = Max(ase1,ase2) = 0.24250288
              bo_2 = 192.00
              ho_2 = 192.00
               bi2_2 = 147456.00
        psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
      -----------------------------------------------------------------
        psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
           ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
              Ash1 = Astir_1*ns_1 = 157.0796
                 No stirups, ns_1 = 2.00
              h1 = 400.00
           ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
              Ash2 = Astir_2*ns_2 = 100.531
                 No stirups, ns_2 = 2.00
              h2 = 200.00
      -----------------------------------------------------------------
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
           ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
              Ash1 = Astir_1*ns_1 = 157.0796
                 No stirups, ns_1 = 2.00
              h1 = 400.00
           ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
              Ash2 = Astir_2*ns_2 = 100.531
                 No stirups, ns_2 = 2.00
              h2 = 200.00
      -----------------------------------------------------------------
           Asec = 160000.00
           s1 = 100.00
           s2 = 250.00
         fywe1 = 694.4444
         fywe2 = 555.5556
         fce  = 33.00
      From ((5.A5), TBDY), TBDY:  cc = 0.00332119
           c  = confinement factor = 1.13212
   y1 = 0.00140044
  sh1 = 0.0044814
 ft1 = 441.538
 fy1 = 367.9484
  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 = 367.9484
     with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
   y2 = 0.00140044
  sh2 = 0.0044814
 ft2 = 441.538
 fy2 = 367.9484
  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 = 367.9484
 with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
 yv = 0.00140044
 shv = 0.0044814
 ftv = 466.813
 fyv = 389.0108
 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 = 389.0108
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
 2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
 v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
 b = 340.00
 d = 327.00
 d' = 13.00
 fcc (5A.2, TBDY) = 37.35991
  cc (5A.5, TBDY) = 0.00332119
   c = confinement factor = 1.13212
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
  2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
  v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
 u = su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
 b = 400.00
 d = 357.00
 d' = 43.00
 v = 0.00126831
  N = 5976.808
 fc = 33.00
  co (5A.5, TBDY) = 0.002
 Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
  The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: cu = 0.01608084
   we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.09892348
  where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----
   fx = 0.07683125
    af = 0.57333333
      b = 400.00
      h = 400.00
   From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
      bw = 400.00
   effective stress from (A.35), ff,e = 870.5244
----
   fy = 0.07683125
    af = 0.57333333
      b = 400.00
      h = 400.00
   From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
      bw = 400.00
   effective stress from (A.35), ff,e = 870.5244

   R = 40.00
   Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
   fu,f = 1055.00
   Ef = 64828.00
    u,f = 0.015
   ase ((5.4d), TBDY) = (ase1*Aext+ ase2*Aint)/Asec = 0.24250288
      ase1 = 0.24250288
         bo_1 = 340.00
         ho_1 = 340.00
          bi2_1 = 462400.00
      ase2 = Max(ase1,ase2) = 0.24250288
         bo_2 = 192.00
         ho_2 = 192.00
          bi2_2 = 147456.00
   psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
----
   psh_x*Fywe = psh1*Fywe1+ ps2*Fywe2 = 3.00633
      ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
         Ash1 = Astir_1*ns_1 = 157.0796
            No stirups, ns_1 = 2.00
         h1 = 400.00
      ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
         Ash2 = Astir_2*ns_2 = 100.531
            No stirups, ns_2 = 2.00
         h2 = 200.00
----
   psh_y*Fywe = psh1*Fywe1+ ps2*Fywe2 = 3.00633
      ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
         Ash1 = Astir_1*ns_1 = 157.0796
            No stirups, ns_1 = 2.00
         h1 = 400.00
      ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
         Ash2 = Astir_2*ns_2 = 100.531
            No stirups, ns_2 = 2.00
         h2 = 200.00

      Asec = 160000.00
      s1 = 100.00
      s2 = 250.00
    fywe1 = 694.4444
    fywe2 = 555.5556
    fce = 33.00
  From ((5.A5), TBDY), TBDY: cc = 0.00332119
      c = confinement factor = 1.13212
 y1 = 0.00140044
 sh1 = 0.0044814
ft1 = 441.538

fy1 = 367.9484
  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 = 367.9484
      with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.00140044
  sh2 = 0.00448144
ft2 = 441.538
fy2 = 367.9484
  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 = 367.9484
      with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00140044
  shv = 0.00448144
ftv = 466.813
fyv = 389.0108
  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 = 389.0108
      with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
    2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
    v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
  b = 340.00
  d = 327.00
  d' = 13.00
  fcc (5A.2, TBDY) = 37.35991
    cc (5A.5, TBDY) = 0.00332119
      c = confinement factor = 1.13212
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
    2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
    v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
  u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
    N = 5976.808
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.01608084
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.09892348
    where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
      ----
      fx = 0.07683125
      af = 0.57333333
        b = 400.00
        h = 400.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
        bw = 400.00
      effective stress from (A.35), ff,e = 870.5244
      ----
      fy = 0.07683125
      af = 0.57333333
        b = 400.00
        h = 400.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
        bw = 400.00
      effective stress from (A.35), ff,e = 870.5244

      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
      fu,f = 1055.00
      Ef = 64828.00
       u,f = 0.015
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
        ase1 = 0.24250288
          bo_1 = 340.00
          ho_1 = 340.00
            bi2_1 = 462400.00
        ase2 = Max(ase1,ase2) = 0.24250288
          bo_2 = 192.00
          ho_2 = 192.00
            bi2_2 = 147456.00
      psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
      ----
      psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
        ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
          Ash1 = Astir_1*ns_1 = 157.0796
            No stirups, ns_1 = 2.00
          h1 = 400.00

```
        ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
            Ash2 = Astir_2*ns_2 = 100.531
                No stirups, ns_2 = 2.00
            h2 = 200.00
      -----------------------------------------------------------------
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
            ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
                Ash1 = Astir_1*ns_1 = 157.0796
                    No stirups, ns_1 = 2.00
                h1 = 400.00
            ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
                Ash2 = Astir_2*ns_2 = 100.531
                    No stirups, ns_2 = 2.00
                h2 = 200.00
      -----------------------------------------------------------------
            Asec = 160000.00
            s1 = 100.00
            s2 = 250.00
          fywe1 = 694.4444
          fywe2 = 555.5556
          fce = 33.00
      From ((5.A5), TBDY), TBDY:  cc = 0.00332119
          c = confinement factor = 1.13212
   y1 = 0.00140044
   sh1 = 0.0044814
 ft1 = 441.538
 fy1 = 367.9484
   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 = 367.9484
         with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
   y2 = 0.00140044
   sh2 = 0.0044814
 ft2 = 441.538
 fy2 = 367.9484
   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 = 367.9484
         with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
   yv = 0.00140044
   shv = 0.0044814
 ftv = 466.813
 fyv = 389.0108
   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 = 389.0108
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
  2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
  v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
 b = 340.00
 d = 327.00
 d' = 13.00
 fcc (5A.2, TBDY) = 37.35991
  cc (5A.5, TBDY) = 0.00332119
     c = confinement factor = 1.13212
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
    2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
    v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
 u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
 b = 400.00
 d = 357.00
 d' = 43.00
 v = 0.00126831
    N = 5976.808
 fc = 33.00
  co (5A.5, TBDY) = 0.002
 Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.01608084
     we ((5.4c), TBDY) = ase* sh,min*fywe/fce+ Min(fx,   fy) = 0.09892348
    where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----
     fx = 0.07683125
      af = 0.57333333
        b = 400.00
        h = 400.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
        bw = 400.00
      effective stress from (A.35), ff,e = 870.5244
    ----
     fy = 0.07683125
      af = 0.57333333
        b = 400.00

```
        h = 400.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
         bw = 400.00
      effective stress from (A.35), ff,e = 870.5244
  --------------------------------------------------------------------
      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
      fu,f = 1055.00
      Ef = 64828.00
       u,f = 0.015
      ase ((5.4d), TBDY) = (ase1*Aext+ ase2*Aint)/Asec = 0.24250288
         ase1 = 0.24250288
            bo_1 = 340.00
            ho_1 = 340.00
             bi2_1 = 462400.00
         ase2 = Max(ase1,ase2) = 0.24250288
            bo_2 = 192.00
            ho_2 = 192.00
             bi2_2 = 147456.00
      psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
  --------------------------------------------------------------------
      psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
         ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
            Ash1 = Astir_1*ns_1 = 157.0796
               No stirups, ns_1 = 2.00
            h1 = 400.00
         ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
            Ash2 = Astir_2*ns_2 = 100.531
               No stirups, ns_2 = 2.00
            h2 = 200.00
  --------------------------------------------------------------------
      psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
         ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
            Ash1 = Astir_1*ns_1 = 157.0796
               No stirups, ns_1 = 2.00
            h1 = 400.00
         ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
            Ash2 = Astir_2*ns_2 = 100.531
               No stirups, ns_2 = 2.00
            h2 = 200.00
  --------------------------------------------------------------------
         Asec = 160000.00
         s1 = 100.00
         s2 = 250.00
      fywe1 = 694.4444
      fywe2 = 555.5556
      fce = 33.00
    From ((5.A5), TBDY), TBDY:  cc = 0.00332119
         c = confinement factor = 1.13212
  y1 = 0.00140044
 sh1 = 0.0044814
ft1 = 441.538
fy1 = 367.9484
 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 = 367.9484
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
```

ft2 = 441.538
fy2 = 367.9484
  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 = 367.9484
      with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
   yv = 0.00140044
   shv = 0.0044814
  ftv = 466.813
  fyv = 389.0108
   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 = 389.0108
      with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
   2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
   v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
  b = 340.00
  d = 327.00
  d' = 13.00
  fcc (5A.2, TBDY) = 37.35991
   cc (5A.5, TBDY) = 0.00332119
      c = confinement factor = 1.13212
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
   2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
   v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
  u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 633070.334

Calculation of Shear Strength at edge 1, Vr1 = 633070.334
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 633070.334
  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 = 29.75, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
   M/Vd = 2.00
      Mu = 1.4989884E-012
      Vu = 3.2548216E-032
    d = 0.8*h = 320.00
    Nu = 5976.808
    Ag = 160000.00
    From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279252.68
    where:
    Vs1 = 279252.68 is calculated for jacket, with:
      d = 320.00
      Av = 157079.633
      fy = 555.5556
      s = 100.00
    Vs1 is multiplied by  Col1 = 1.00
      s/d = 0.3125
    Vs2 = 0.00 is calculated for core, with:
      d = 160.00
      Av = 100530.965
      fy = 444.4444
      s = 250.00
    Vs2 is multiplied by  Col2 = 0.00
      s/d = 1.5625
    Vf ((11-3)-(11.4), ACI 440) = 188111.148
      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)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,β), 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:  β1 = b1 + 90° = 90.00
   Vf = Min(|Vf(45,β1)|,|Vf(-45,a1)|), with:
   total thickness per orientation, tf1 = NL*t/NoDir = 1.016
   dfv = d (figure 11.2, ACI 440) = 357.00
   ffe ((11-5), ACI 440) = 259.312
      Ef = 64828.00
      εfe = 0.004, from (11.6a), ACI 440
        with εfu = 0.01
    From (11-11), ACI 440: Vs + Vf <= 463788.751
      bw = 400.00
----------------------------------------------------------------
----------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 633070.334
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
   VCol0 = 633070.334
   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 = 29.75, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
   M/Vd = 2.00
      Mu = 1.4989884E-012
      Vu = 3.2548216E-032
    d = 0.8*h = 320.00
    Nu = 5976.808
    Ag = 160000.00
    From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279252.68
    where:
```

Vs1 = 279252.68 is calculated for jacket, with:
    d = 320.00
    Av = 157079.633
    fy = 555.5556
    s = 100.00
  Vs1 is multiplied by   Col1 = 1.00
    s/d = 0.3125
  Vs2 = 0.00 is calculated for core, with:
    d = 160.00
    Av = 100530.965
    fy = 444.4444
    s = 250.00
  Vs2 is multiplied by   Col2 = 0.00
    s/d = 1.5625
  Vf ((11-3)-(11.4), ACI 440) = 188111.148
    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 = 1.016
  dfv = d (figure 11.2, ACI 440) = 357.00
  ffe ((11-5), ACI 440) = 259.312
    Ef = 64828.00
     fe = 0.004, from (11.6a), ACI 440
       with fu = 0.01
   From (11-11), ACI 440: Vs + Vf < = 463788.751
     bw = 400.00

End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rcjrs

Constant Properties

Knowledge Factor,   = 0.85
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 = 555.5556
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member

Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups 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
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
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 = 0.04224678
Shear Force, V2 = 4560.604
Shear Force, V3 = -9.4294951E-014
Axial Force, F = -5974.983
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1137.257
     -Compression: Asl,com = 1137.257
         -Middle: Asl,mid = 402.1239
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,jacket = 829.3805
     -Compression: Asl,com,jacket = 829.3805
         -Middle: Asl,mid,jacket = 402.1239
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,core = 307.8761
     -Compression: Asl,com,core = 307.8761
         -Middle: Asl,mid,core = 0.00
Mean Diameter of Tension Reinforcement, DbL = 16.80

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $\theta_{u,R}$ = $*$ θ_u = 0.00060387
 θ_u = θ_y + θ_p = 0.00071043

 - Calculation of θ_y -

 θ_y = (My*Ls/3)/EIeff = 0.00071043 ((4.29),Biskinis Phd))
 My = 1.2106E+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 = 1.7040E+013
    factor = 0.30
       Ag = 160000.00
       Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 29.75
       N = 5974.983
    Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.6801E+013

Calculation of Yielding Moment My

Calculation of θ_y and My according to Annex 7 -

 θ_y = Min(θ_{y_ten}, θ_{y_com})

```
  y_ten = 5.7839617E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 296.8901
    d = 357.00
     y = 0.28109392
    A = 0.01888489
    B = 0.01064175
     with pt = 0.00680079
        pc = 0.00796398
        pv = 0.00281599
        N = 5974.983
        b = 400.00
         " = 0.12044818
  y_comp = 2.3130538E-005
with fc* (12.3, (ACI 440)) = 34.65043
    fc = 33.00
    fl = 0.93147527
    b = 400.00
    h = 400.00
    Ag = 160000.00
    From (12.9), ACI 440: ka = 0.56518315
        g = pt + pc + pv = 0.01874396
       rc = 40.00
       Ae/Ac = 0.56518315
       Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
     effective strain from (12.5) and (12.12), efe = 0.004
      fu = 0.01
    Ef = 64828.00
    Ec = 26999.444
     y = 0.27975148
    A = 0.01865339
    B = 0.01050082
     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 = 0.18171192
   d = d_external = 357.00
   s = s_external = 0.00
    t =   s1 +   s2 + 2*tf/bw*(ffe/fs) = 0.00680079
  jacket:  s1 = Av1*h1/(s1*Ag) = 0.00392699
       Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
       h1 = 400.00
       s1 = 100.00
   core:    s2 = Av2*h2/(s2*Ag) = 0.00050265
       Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
       h2 = 200.00
       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 = 5974.983
    Ag = 160000.00
    f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 29.75
    fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein =
529.9948
    fytE = (fy_ext_Trans_Reinf*Area_ext_Trans_Reinf+fy_int_Trans_Reinf*Area_int_Trans_Reinf)/Area_Tot_Trans_Rein =
```

542.9472
pl = Area_Tot_Long_Rein/(b*d) = 0.01874396
   b = 400.00
   d = 357.00
    f'cE = 29.75

End Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 3
Integration Section: (b)

Calculation No. 9

column C1, Floor 1

Limit State: Collapse Prevention (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 JC1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rcjrs

Constant Properties

Knowledge Factor,   = 0.85
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
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of y for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, 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 = 555.5556
Existing Column
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.4444
##
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups 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
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
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 = -1.7103E+007
Shear Force, Va = -5699.261
EDGE -B-
Bending Moment, Mb = 0.05279463
Shear Force, Vb = 5699.261
BOTH EDGES
Axial Force, F = -5974.527
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 1137.257
    -Compression: Aslc = 1539.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 1137.257
    -Compression: Asl,com = 1137.257
       -Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL,ten = 16.80

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR =   *Vn = 409879.585
Vn ((10.3), ASCE 41-17) = knl*VColO = 482211.277
   VCol = 482211.277
   knl = 1.00

displacement_ductility_demand = 0.04004211

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 = 22.75, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
     Mu = 1.7103E+007
     Vu = 5699.261
   d = 0.8*h = 320.00
   Nu = 5974.527
   Ag = 160000.00
   From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 251327.412
   where:
   Vs1 = 251327.412 is calculated for jacket, with:
      d = 320.00
      Av = 157079.633
      fy = 500.00
      s = 100.00
   Vs1 is multiplied by   Col1 = 1.00
      s/d = 0.3125
   Vs2 = 0.00 is calculated for core, with:
      d = 160.00
      Av = 100530.965
      fy = 400.00
      s = 250.00
   Vs2 is multiplied by   Col2 = 0.00
      s/d = 1.5625
   Vf ((11-3)-(11.4), ACI 440) = 188111.148
      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 = 1.016
   dfv = d (figure 11.2, ACI 440) = 357.00
   ffe ((11-5), ACI 440) = 259.312
      Ef = 64828.00
      fe = 0.004, from (11.6a), ACI 440
        with fu = 0.01
   From (11-11), ACI 440: Vs + Vf <= 405571.497
      bw = 400.00

----
displacement_ductility_demand is calculated as / y

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

From analysis, chord rotation   = 0.00028456
 y = (My*Ls/3)/EIeff = 0.00710641 ((4.29),Biskinis Phd))
  My = 1.2106E+008
  Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3000.891
  From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7040E+013
     factor = 0.30
        Ag = 160000.00
        Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 29.75
        N = 5974.527
     Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.6801E+013

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7 -
----
  y = Min(y_ten, y_com)
  y_ten = 5.7839606E-006
  with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 296.8901
    d = 357.00
     y = 0.28109378
    A = 0.01888488
    B = 0.01064174
     with pt = 0.00796398
        pc = 0.00796398
        pv = 0.00281599
        N = 5974.527
        b = 400.00
         " = 0.12044818
  y_comp = 2.3130541E-005
  with fc* (12.3, (ACI 440)) = 34.65043
    fc = 33.00
    fl = 0.93147527
    b = 400.00
    h = 400.00
    Ag = 160000.00
    From (12.9), ACI 440: ka = 0.56518315
       g = pt + pc + pv = 0.01874396
      rc = 40.00
      Ae/Ac = 0.56518315
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
     effective strain from (12.5) and (12.12), efe = 0.004
      fu = 0.01
    Ef = 64828.00
    Ec = 26999.444
     y = 0.27975145
    A = 0.0186534
    B = 0.01050082
     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 JC1 of floor 1
At local axis: 2
Integration Section: (a)

Calculation No. 10

column C1, Floor 1

Limit State: Collapse Prevention (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 JC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcjrs

Constant Properties

Knowledge Factor,   = 0.85
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 = 555.5556
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.4444
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556
##
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.13212
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups 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
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
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 = -1.8468314E-031
EDGE -B-
Shear Force, Vb = 1.8468314E-031
BOTH EDGES
Axial Force, F = -5976.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
       -Tension: Aslt = 0.00
     -Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
       -Tension: Asl,ten = 1137.257
     -Compression: Asl,com = 1137.257
        -Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.18171192
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 115036.425
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.7255E+008
  Mu1+ = 1.7255E+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- = 1.7255E+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-) = 1.7255E+008
  Mu2+ = 1.7255E+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- = 1.7255E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
    N = 5976.808
  fc = 33.00
   co (5A.5, TBDY) = 0.002

Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
   The Shear_factor is considered equal to 1 (pure moment strength)
  From (5.4b), TBDY: cu = 0.01608084
   we ((5.4c), TBDY) = ase* sh,min*fywe/fce + Min(fx, fy) = 0.09892348
  where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----
  fx = 0.07683125
   af = 0.57333333
    b = 400.00
    h = 400.00
  From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
    bw = 400.00
  effective stress from (A.35), ff,e = 870.5244
----
  fy = 0.07683125
   af = 0.57333333
    b = 400.00
    h = 400.00
  From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
    bw = 400.00
  effective stress from (A.35), ff,e = 870.5244

  R = 40.00
  Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
  fu,f = 1055.00
  Ef = 64828.00
  u,f = 0.015
  ase ((5.4d), TBDY) = (ase1*Aext + ase2*Aint)/Asec = 0.24250288
   ase1 = 0.24250288
    bo_1 = 340.00
    ho_1 = 340.00
    bi2_1 = 462400.00
   ase2 = Max(ase1,ase2) = 0.24250288
    bo_2 = 192.00
    ho_2 = 192.00
    bi2_2 = 147456.00
  psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
----
  psh_x*Fywe = psh1*Fywe1 + ps2*Fywe2 = 3.00633
   ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
    Ash1 = Astir_1*ns_1 = 157.0796
     No stirups, ns_1 = 2.00
    h1 = 400.00
   ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
    Ash2 = Astir_2*ns_2 = 100.531
     No stirups, ns_2 = 2.00
    h2 = 200.00
----
  psh_y*Fywe = psh1*Fywe1 + ps2*Fywe2 = 3.00633
   ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
    Ash1 = Astir_1*ns_1 = 157.0796
     No stirups, ns_1 = 2.00
    h1 = 400.00
   ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
    Ash2 = Astir_2*ns_2 = 100.531
     No stirups, ns_2 = 2.00
    h2 = 200.00

    Asec = 160000.00
    s1 = 100.00
    s2 = 250.00
   fywe1 = 694.4444
   fywe2 = 555.5556
   fce = 33.00
  From ((5.A5), TBDY), TBDY: cc = 0.00332119
   c = confinement factor = 1.13212
y1 = 0.00140044

sh1 = 0.0044814
ft1 = 441.538
fy1 = 367.9484
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 = 367.9484
   with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 441.538
fy2 = 367.9484
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 = 367.9484
   with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.813
fyv = 389.0108
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 = 389.0108
   with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
  2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
  v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
  b = 340.00
  d = 327.00
  d' = 13.00
  fcc (5A.2, TBDY) = 37.35991
  cc (5A.5, TBDY) = 0.00332119
   c = confinement factor = 1.13212
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
   2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
   v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408

Mu = MRc (4.14) = 1.7255E+008
  u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
    N = 5976.808
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: cu = 0.01608084
       we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx,   fy) = 0.09892348
     where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
     ----
       fx = 0.07683125
       af = 0.57333333
          b = 400.00
          h = 400.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
          bw = 400.00
        effective stress from (A.35), ff,e = 870.5244
     ----
       fy = 0.07683125
       af = 0.57333333
          b = 400.00
          h = 400.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
          bw = 400.00
        effective stress from (A.35), ff,e = 870.5244

       R = 40.00
       Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
       fu,f = 1055.00
       Ef = 64828.00
        u,f = 0.015
       ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
          ase1 = 0.24250288
             bo_1 = 340.00
             ho_1 = 340.00
               bi2_1 = 462400.00
          ase2 = Max(ase1,ase2) = 0.24250288
             bo_2 = 192.00
             ho_2 = 192.00
               bi2_2 = 147456.00
       psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
     ----
       psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
          ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
             Ash1 = Astir_1*ns_1 = 157.0796

```
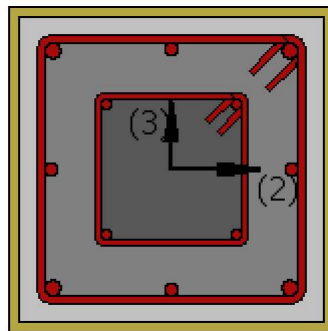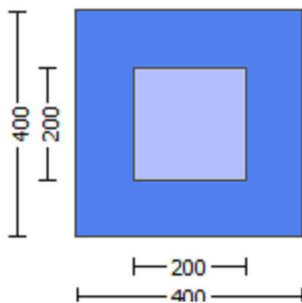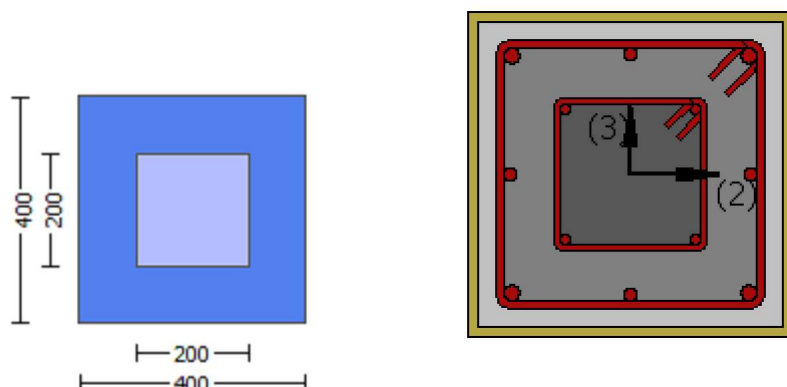                    No stirups, ns_1 = 2.00
                h1 = 400.00
            ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
                Ash2 = Astir_2*ns_2 = 100.531
                    No stirups, ns_2 = 2.00
                h2 = 200.00
      ----------------------------------------------------------------
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
            ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
                Ash1 = Astir_1*ns_1 = 157.0796
                    No stirups, ns_1 = 2.00
                h1 = 400.00
            ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
                Ash2 = Astir_2*ns_2 = 100.531
                    No stirups, ns_2 = 2.00
                h2 = 200.00
      ----------------------------------------------------------------
        Asec = 160000.00
        s1 = 100.00
        s2 = 250.00
     fywe1 = 694.4444
     fywe2 = 555.5556
      fce = 33.00
   From ((5.A5), TBDY), TBDY:  cc = 0.00332119
        c = confinement factor = 1.13212
  y1 = 0.00140044
  sh1 = 0.0044814
 ft1 = 441.538
fy1 = 367.9484
 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 = 367.9484
      with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.00140044
  sh2 = 0.0044814
 ft2 = 441.538
fy2 = 367.9484
 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 = 367.9484
      with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00140044
  shv = 0.0044814
 ftv = 466.813
fyv = 389.0108
 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 ω_{yv}, ω_{shv},ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
ω_{y1}, ω_{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 = 389.0108
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω_1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
ω_2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
ω_v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
 b = 340.00
 d = 327.00
 d' = 13.00
 fcc (5A.2, TBDY) = 37.35991
 ϵcc (5A.5, TBDY) = 0.00332119
   λ_c = confinement factor = 1.13212
 ω_1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
 ω_2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
 ω_v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
ω_v < $\omega_{vs,y2}$ - LHS eq.(4.5) is satisfied
--->
 ϵsu (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
 ϕ_u = ϕsu (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature ϕu according to 4.1, Biskinis/Fardis 2013:
 ϕu = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
 b = 400.00
 d = 357.00
 d' = 43.00
 v = 0.00126831
   N = 5976.808
 fc = 33.00
 ϵco (5A.5, TBDY) = 0.002
 Final value of ϵcu: ϵcu* = shear_factor * Max(ϵcu, ϵcc) = 0.01608084
   The Shear_factor is considered equal to 1 (pure moment strength)
   From (5.4b), TBDY: ϵcu = 0.01608084
     ω_{we} ((5.4c), TBDY) = α_{se}* $\rho_{sh,min}$*fywe/fce+Min(ω_{fx}, ω_{fy}) = 0.09892348
   where ω_f = α_f*ρ_f*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

     ω_{fx} = 0.07683125
     α_f = 0.57333333
        b = 400.00
        h = 400.00
     From EC8 A.4.4.3(6), ρ_f = 2tf/bw = 0.00508
        bw = 400.00
     effective stress from (A.35), ff,e = 870.5244

     ω_{fy} = 0.07683125

af = 0.57333333
  b = 400.00
  h = 400.00
From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
  bw = 400.00
effective stress from (A.35), ff,e = 870.5244

R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
 u,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
  ase1 = 0.24250288
    bo_1 = 340.00
    ho_1 = 340.00
     bi2_1 = 462400.00
  ase2 = Max(ase1,ase2) = 0.24250288
    bo_2 = 192.00
    ho_2 = 192.00
     bi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
  ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
    Ash1 = Astir_1*ns_1 = 157.0796
     No stirups, ns_1 = 2.00
    h1 = 400.00
  ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
    Ash2 = Astir_2*ns_2 = 100.531
     No stirups, ns_2 = 2.00
    h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
  ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
    Ash1 = Astir_1*ns_1 = 157.0796
     No stirups, ns_1 = 2.00
    h1 = 400.00
  ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
    Ash2 = Astir_2*ns_2 = 100.531
     No stirups, ns_2 = 2.00
    h2 = 200.00

  Asec = 160000.00
  s1 = 100.00
  s2 = 250.00
fywe1 = 694.4444
fywe2 = 555.5556
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00332119
  c = confinement factor = 1.13212
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 441.538
fy1 = 367.9484
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 = 367.9484
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

$y2 = 0.00140044$
$sh2 = 0.0044814$
$ft2 = 441.538$
$fy2 = 367.9484$
$su2 = 0.00512$
  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 = 367.9484
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
$yv = 0.00140044$
$shv = 0.0044814$
$ftv = 466.813$
$fyv = 389.0108$
$suv = 0.00512$
  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 = 389.0108
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
  2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
  v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
  b = 340.00
  d = 327.00
  d' = 13.00
  fcc (5A.2, TBDY) = 37.35991
   cc (5A.5, TBDY) = 0.00332119
     c = confinement factor = 1.13212
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
    2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
    v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
 u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

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

```
  u = 1.7890363E-005
Mu = 1.7255E+008
--------------------------------------------------------------------------
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
    N = 5976.808
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of  cu:  cu* = shear_factor * Max( cu, cc) = 0.01608084
      The Shear_factor is considered equal to 1 (pure moment strength)
      From (5.4b), TBDY:  cu = 0.01608084
        we ((5.4c), TBDY) = ase*  sh,min*fywe/fce+Min(  fx,   fy) = 0.09892348
      where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
      -------------------------------------------------------------------
        fx = 0.07683125
        af = 0.57333333
          b = 400.00
          h = 400.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
          bw = 400.00
        effective stress from (A.35), ff,e = 870.5244
      -------------------------------------------------------------------
        fy = 0.07683125
        af = 0.57333333
          b = 400.00
          h = 400.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
          bw = 400.00
        effective stress from (A.35), ff,e = 870.5244
      -------------------------------------------------------------------
        R = 40.00
        Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
        fu,f = 1055.00
        Ef = 64828.00
         u,f = 0.015
        ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
            ase1 = 0.24250288
              bo_1 = 340.00
              ho_1 = 340.00
               bi2_1 = 462400.00
          ase2 = Max(ase1,ase2) = 0.24250288
              bo_2 = 192.00
              ho_2 = 192.00
               bi2_2 = 147456.00
        psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
      -------------------------------------------------------------------
        psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
          ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
            Ash1 = Astir_1*ns_1 = 157.0796
               No stirups, ns_1 = 2.00
            h1 = 400.00
          ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
            Ash2 = Astir_2*ns_2 = 100.531
               No stirups, ns_2 = 2.00
            h2 = 200.00
      -------------------------------------------------------------------
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
          ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
            Ash1 = Astir_1*ns_1 = 157.0796
               No stirups, ns_1 = 2.00
            h1 = 400.00
          ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
            Ash2 = Astir_2*ns_2 = 100.531
               No stirups, ns_2 = 2.00
```

```
          h2 = 200.00
     ----------------------------------------------------------------
         Asec = 160000.00
          s1 = 100.00
          s2 = 250.00
       fywe1 = 694.4444
       fywe2 = 555.5556
        fce  = 33.00
     From ((5.A5), TBDY), TBDY:  cc = 0.00332119
         c  = confinement factor = 1.13212
   y1 = 0.00140044
   sh1 = 0.0044814
 ft1 = 441.538
 fy1 = 367.9484
   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 = 367.9484
       with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
   y2 = 0.00140044
   sh2 = 0.0044814
 ft2 = 441.538
 fy2 = 367.9484
   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 = 367.9484
       with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
   yv = 0.00140044
   shv = 0.0044814
 ftv = 466.813
 fyv = 389.0108
   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 = 389.0108
       with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
     2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
     v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
 and confined core properties:
   b = 340.00
   d = 327.00
   d' = 13.00
 fcc (5A.2, TBDY) = 37.35991
```

cc (5A.5, TBDY) = 0.00332119
    c = confinement factor = 1.13212
  ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
  ω2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
  ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 εsu (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
  φu = φsu (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 633070.334

Calculation of Shear Strength at edge 1, Vr1 = 633070.334
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 633070.334
  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 = 29.75, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
    Mu = 8.4878329E-012
    Vu = 1.8468314E-031
  d = 0.8*h = 320.00
  Nu = 5976.808
  Ag = 160000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279252.68
  where:
  Vs1 = 279252.68 is calculated for jacket, with:
    d = 320.00
    Av = 157079.633
    fy = 555.5556
    s = 100.00
  Vs1 is multiplied by Col1 = 1.00
    s/d = 0.3125
  Vs2 = 0.00 is calculated for core, with:
    d = 160.00
    Av = 100530.965
    fy = 444.4444
    s = 250.00
  Vs2 is multiplied by Col2 = 0.00
    s/d = 1.5625
  Vf ((11-3)-(11.4), ACI 440) = 188111.148
    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)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 = 1.016

```
   dfv = d (figure 11.2, ACI 440) = 357.00
   ffe ((11-5), ACI 440) = 259.312
      Ef = 64828.00
       fe = 0.004, from (11.6a), ACI 440
         with  fu = 0.01
   From (11-11), ACI 440: Vs + Vf <= 463788.751
      bw = 400.00
---------------------------------------------------------------
---------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 633070.334
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
   VCol0 = 633070.334
   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 = 29.75, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
   M/Vd = 2.00
      Mu = 8.4878329E-012
      Vu = 1.8468314E-031
   d = 0.8*h = 320.00
   Nu = 5976.808
   Ag = 160000.00
   From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279252.68
   where:
   Vs1 = 279252.68 is calculated for jacket, with:
      d = 320.00
      Av = 157079.633
      fy = 555.5556
      s = 100.00
   Vs1 is multiplied by   Col1 = 1.00
      s/d = 0.3125
   Vs2 = 0.00 is calculated for core, with:
      d = 160.00
      Av = 100530.965
      fy = 444.4444
      s = 250.00
   Vs2 is multiplied by   Col2 = 0.00
      s/d = 1.5625
   Vf ((11-3)-(11.4), ACI 440) = 188111.148
      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 = 1.016
   dfv = d (figure 11.2, ACI 440) = 357.00
   ffe ((11-5), ACI 440) = 259.312
      Ef = 64828.00
       fe = 0.004, from (11.6a), ACI 440
         with  fu = 0.01
   From (11-11), ACI 440: Vs + Vf <= 463788.751
      bw = 400.00
---------------------------------------------------------------
---------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 3


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

Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjrs

Constant Properties

Knowledge Factor, = 0.85
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 = 555.5556
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.4444
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556
##
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.13212
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups 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
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
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 = 3.2548216E-032
EDGE -B-
Shear Force, Vb = -3.2548216E-032
BOTH EDGES
Axial Force, F = -5976.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
   -Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: Asl,ten = 1137.257
        -Compression: Asl,com = 1137.257
            -Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.18171192
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 115036.425
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.7255E+008
   Mu1+ = 1.7255E+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- = 1.7255E+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-) = 1.7255E+008
   Mu2+ = 1.7255E+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- = 1.7255E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
     N = 5976.808
  fc = 33.00
   εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.01608084
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: εcu = 0.01608084
        ωwe ((5.4c), TBDY) = αse*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.09892348
     where ωf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

        ωfx = 0.07683125
        αf = 0.57333333
           b = 400.00
           h = 400.00
        From EC8 A 4.4.3(6), ρf = 2tf/bw = 0.00508
           bw = 400.00
        effective stress from (A.35), ff,e = 870.5244

        ωfy = 0.07683125
        αf = 0.57333333
           b = 400.00
           h = 400.00
        From EC8 A 4.4.3(6), ρf = 2tf/bw = 0.00508
           bw = 400.00
        effective stress from (A.35), ff,e = 870.5244

        R = 40.00
        Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
        fu,f = 1055.00
        Ef = 64828.00
         εu,f = 0.015
        αse ((5.4d), TBDY) = (αse1*Aext+αse2*Aint)/Asec = 0.24250288

```
            ase1 = 0.24250288
                bo_1 = 340.00
                ho_1 = 340.00
                 bi2_1 = 462400.00
          ase2 = Max(ase1,ase2) = 0.24250288
                bo_2 = 192.00
                ho_2 = 192.00
                 bi2_2 = 147456.00
          psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
       -------------------------------------------------------------
          psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
             ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
                Ash1 = Astir_1*ns_1 = 157.0796
                   No stirups, ns_1 = 2.00
                h1 = 400.00
             ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
                Ash2 = Astir_2*ns_2 = 100.531
                   No stirups, ns_2 = 2.00
                h2 = 200.00
       -------------------------------------------------------------
          psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
             ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
                Ash1 = Astir_1*ns_1 = 157.0796
                   No stirups, ns_1 = 2.00
                h1 = 400.00
             ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
                Ash2 = Astir_2*ns_2 = 100.531
                   No stirups, ns_2 = 2.00
                h2 = 200.00
       -------------------------------------------------------------
             Asec = 160000.00
             s1 = 100.00
             s2 = 250.00
          fywe1 = 694.4444
          fywe2 = 555.5556
          fce  = 33.00
       From ((5.A5), TBDY), TBDY:  cc = 0.00332119
             c  = confinement factor = 1.13212
    y1 = 0.00140044
   sh1 = 0.0044814
  ft1 = 441.538
  fy1 = 367.9484
   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 = 367.9484
      with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
    y2 = 0.00140044
   sh2 = 0.0044814
  ft2 = 441.538
  fy2 = 367.9484
   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 = 367.9484
  with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.813
fyv = 389.0108
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 = 389.0108
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
cc (5A.5, TBDY) = 0.00332119
  c = confinement factor = 1.13212
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
u = su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
  N = 5976.808
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
  The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: cu = 0.01608084
   we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.09892348
 where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----
  fx = 0.07683125
   af = 0.57333333
      b = 400.00
      h = 400.00
   From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
      bw = 400.00
   effective stress from (A.35), ff,e = 870.5244
----
  fy = 0.07683125
   af = 0.57333333
      b = 400.00
      h = 400.00
   From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
      bw = 400.00
   effective stress from (A.35), ff,e = 870.5244

  R = 40.00
  Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
  fu,f = 1055.00
  Ef = 64828.00
   u,f = 0.015
  ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
     ase1 = 0.24250288
        bo_1 = 340.00
        ho_1 = 340.00
         bi2_1 = 462400.00
     ase2 = Max(ase1,ase2) = 0.24250288
        bo_2 = 192.00
        ho_2 = 192.00
         bi2_2 = 147456.00
  psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
----
  psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
     ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
        Ash1 = Astir_1*ns_1 = 157.0796
           No stirups, ns_1 = 2.00
        h1 = 400.00
     ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
        Ash2 = Astir_2*ns_2 = 100.531
           No stirups, ns_2 = 2.00
        h2 = 200.00
----
  psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
     ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
        Ash1 = Astir_1*ns_1 = 157.0796
           No stirups, ns_1 = 2.00
        h1 = 400.00
     ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
        Ash2 = Astir_2*ns_2 = 100.531
           No stirups, ns_2 = 2.00
        h2 = 200.00

     Asec = 160000.00
     s1 = 100.00
     s2 = 250.00
   fywe1 = 694.4444
   fywe2 = 555.5556
   fce = 33.00
 From ((5.A5), TBDY), TBDY: cc = 0.00332119
     c = confinement factor = 1.13212
 y1 = 0.00140044
 sh1 = 0.0044814
ft1 = 441.538

fy1 = 367.9484
  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 = 367.9484
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.00140044
  sh2 = 0.0044814
 ft2 = 441.538
 fy2 = 367.9484
  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 = 367.9484
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00140044
  shv = 0.0044814
 ftv = 466.813
 fyv = 389.0108
  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 = 389.0108
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
  2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
  v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
 b = 340.00
 d = 327.00
 d' = 13.00
 fcc (5A.2, TBDY) = 37.35991
  cc (5A.5, TBDY) = 0.00332119
   c = confinement factor = 1.13212
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
  2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
  v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
 u =   su (4.1) = 1.7890363E-005

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

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


------------------------------------------------------------------------
Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.7890363E-005
Mu = 1.7255E+008
------------------------------------------------------------------------
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
    N = 5976.808
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of  cu:  cu* = shear_factor * Max( cu, cc) = 0.01608084
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY:  cu = 0.01608084
       we ((5.4c), TBDY) = ase*  sh,min*fywe/fce+Min( fx,   fy) = 0.09892348
     where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
     ------------------------------------------------------------------
       fx = 0.07683125
       af = 0.57333333
          b = 400.00
          h = 400.00
        From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
          bw = 400.00
       effective stress from (A.35), ff,e = 870.5244
     ------------------------------------------------------------------
       fy = 0.07683125
       af = 0.57333333
          b = 400.00
          h = 400.00
        From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
          bw = 400.00
       effective stress from (A.35), ff,e = 870.5244
     ------------------------------------------------------------------
       R = 40.00
       Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
       fu,f = 1055.00
       Ef = 64828.00
        u,f = 0.015
       ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
          ase1 = 0.24250288
             bo_1 = 340.00
             ho_1 = 340.00
              bi2_1 = 462400.00
          ase2 = Max(ase1,ase2) = 0.24250288
             bo_2 = 192.00
             ho_2 = 192.00
              bi2_2 = 147456.00
       psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
     ------------------------------------------------------------------
       psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
          ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
             Ash1 = Astir_1*ns_1 = 157.0796
                No stirups, ns_1 = 2.00
             h1 = 400.00
```

```
        ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
            Ash2 = Astir_2*ns_2 = 100.531
               No stirrups, ns_2 = 2.00
            h2 = 200.00
     ----------------------------------------------------------------
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
           ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
              Ash1 = Astir_1*ns_1 = 157.0796
                 No stirrups, ns_1 = 2.00
              h1 = 400.00
           ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
              Ash2 = Astir_2*ns_2 = 100.531
                 No stirrups, ns_2 = 2.00
              h2 = 200.00
     ----------------------------------------------------------------
           Asec = 160000.00
           s1 = 100.00
           s2 = 250.00
        fywe1 = 694.4444
        fywe2 = 555.5556
        fce  = 33.00
     From ((5.A5), TBDY), TBDY:  cc = 0.00332119
         c  = confinement factor = 1.13212
  y1 = 0.00140044
  sh1 = 0.0044814
ft1 = 441.538
fy1 = 367.9484
  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 = 367.9484
       with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.00140044
  sh2 = 0.0044814
ft2 = 441.538
fy2 = 367.9484
  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 = 367.9484
       with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00140044
  shv = 0.0044814
ftv = 466.813
fyv = 389.0108
  suv = 0.00512
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/ld = 0.30
       suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
     From table 5A.1, TBDY: esuv_nominal = 0.08,
     considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
```

For calculation of esuv_nominal and εyv, εshv,εftv,εfyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1, εsh1,εft1,εfy1, 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 = 389.0108
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ρ1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
ρ2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
ρv = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
  b = 340.00
  d = 327.00
  d' = 13.00
  fcc (5A.2, TBDY) = 37.35991
  εcc (5A.5, TBDY) = 0.00332119
    αc = confinement factor = 1.13212
    ρ1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
    ρ2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
    ρv = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
ρv < ρvs,y2 - LHS eq.(4.5) is satisfied
--->
εsu (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
φu = φsu (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  ν = 0.00126831
    N = 5976.808
  fc = 33.00
  εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.01608084
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.01608084
      ωwe ((5.4c), TBDY) = αse*ρsh,min*fywe/fce+Min(αfx, αfy) = 0.09892348
    where αf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

      αfx = 0.07683125
       αf = 0.57333333
         b = 400.00
         h = 400.00
       From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00508
         bw = 400.00
       effective stress from (A.35), ff,e = 870.5244

      αfy = 0.07683125
       αf = 0.57333333
         b = 400.00

154

```
        h = 400.00
      From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
        bw = 400.00
      effective stress from (A.35), ff,e = 870.5244
    ------------------------------------------------------------
      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
      fu,f = 1055.00
      Ef = 64828.00
       u,f = 0.015
      ase ((5.4d), TBDY) = (ase1*Aext+ ase2*Aint)/Asec = 0.24250288
        ase1 = 0.24250288
          bo_1 = 340.00
          ho_1 = 340.00
           bi2_1 = 462400.00
        ase2 = Max(ase1,ase2) = 0.24250288
          bo_2 = 192.00
          ho_2 = 192.00
           bi2_2 = 147456.00
      psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
    ------------------------------------------------------------
      psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
        ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
          Ash1 = Astir_1*ns_1 = 157.0796
            No stirups, ns_1 = 2.00
          h1 = 400.00
        ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
          Ash2 = Astir_2*ns_2 = 100.531
            No stirups, ns_2 = 2.00
          h2 = 200.00
    ------------------------------------------------------------
      psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
        ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
          Ash1 = Astir_1*ns_1 = 157.0796
            No stirups, ns_1 = 2.00
          h1 = 400.00
        ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
          Ash2 = Astir_2*ns_2 = 100.531
            No stirups, ns_2 = 2.00
          h2 = 200.00
    ------------------------------------------------------------
        Asec = 160000.00
        s1 = 100.00
        s2 = 250.00
      fywe1 = 694.4444
      fywe2 = 555.5556
      fce  = 33.00
    From ((5.A5), TBDY), TBDY:  cc = 0.00332119
        c = confinement factor = 1.13212
  y1 = 0.00140044
 sh1 = 0.0044814
ft1 = 441.538
fy1 = 367.9484
 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 = 367.9484
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
 y2 = 0.00140044
 sh2 = 0.0044814
```

ft2 = 441.538
fy2 = 367.9484
 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 = 367.9484
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00140044
  shv = 0.0044814
 ftv = 466.813
 fyv = 389.0108
  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 = 389.0108
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
  2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
  v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
  b = 340.00
  d = 327.00
  d' = 13.00
 fcc (5A.2, TBDY) = 37.35991
  cc (5A.5, TBDY) = 0.00332119
     c = confinement factor = 1.13212
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
   2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
   v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
  u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 633070.334

Calculation of Shear Strength at edge 1, Vr1 = 633070.334
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 633070.334
  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 = 29.75, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
    Mu = 1.4989884E-012
    Vu = 3.2548216E-032
  d = 0.8*h = 320.00
  Nu = 5976.808
  Ag = 160000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279252.68
  where:
  Vs1 = 279252.68 is calculated for jacket, with:
    d = 320.00
    Av = 157079.633
    fy = 555.5556
    s = 100.00
  Vs1 is multiplied by   Col1 = 1.00
    s/d = 0.3125
  Vs2 = 0.00 is calculated for core, with:
    d = 160.00
    Av = 100530.965
    fy = 444.4444
    s = 250.00
  Vs2 is multiplied by   Col2 = 0.00
    s/d = 1.5625
  Vf ((11-3)-(11.4), ACI 440) = 188111.148
    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 = 1.016
  dfv = d (figure 11.2, ACI 440) = 357.00
  ffe ((11-5), ACI 440) = 259.312
    Ef = 64828.00
     fe = 0.004, from (11.6a), ACI 440
       with  fu = 0.01
  From (11-11), ACI 440: Vs + Vf <= 463788.751
    bw = 400.00
--------------------------------------------------------------
--------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 633070.334
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 633070.334
  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 = 29.75, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
    Mu = 1.4989884E-012
    Vu = 3.2548216E-032
  d = 0.8*h = 320.00
  Nu = 5976.808
  Ag = 160000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279252.68
  where:
```

Vs1 = 279252.68 is calculated for jacket, with:
   d = 320.00
   Av = 157079.633
   fy = 555.5556
   s = 100.00
Vs1 is multiplied by Col1 = 1.00
   s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
   d = 160.00
   Av = 100530.965
   fy = 444.4444
   s = 250.00
Vs2 is multiplied by Col2 = 0.00
   s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
  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 = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
  Ef = 64828.00
   fe = 0.004, from (11.6a), ACI 440
    with fu = 0.01
From (11-11), ACI 440: Vs + Vf <= 463788.751
  bw = 400.00

End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rcjrs

Constant Properties

Knowledge Factor, = 0.85
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 = 555.5556
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member

Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups 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
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
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 = -2.1377975E-010
Shear Force, V2 = -5699.261
Shear Force, V3 = 1.1783778E-013
Axial Force, F = -5974.527
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 1137.257
     -Compression: Aslc = 1539.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1137.257
     -Compression: Asl,com = 1137.257
        -Middle: Asl,mid = 402.1239
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,jacket = 829.3805
     -Compression: Asl,com,jacket = 829.3805
        -Middle: Asl,mid,jacket = 402.1239
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,core = 307.8761
     -Compression: Asl,com,core = 307.8761
        -Middle: Asl,mid,core = 0.00
Mean Diameter of Tension Reinforcement, DbL = 16.80

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $\theta_{u,R}$ = * θ_u = 0.03871933
 θ_u = θ_y + θ_p = 0.04555215

 - Calculation of θ_y -

 θ_y = (My*Ls/3)/EIeff = 0.00355215 ((4.29),Biskinis Phd))
  My = 1.2106E+008
  Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
  From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7040E+013
     factor = 0.30
        Ag = 160000.00
        Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 29.75
        N = 5974.527
     Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.6801E+013

Calculation of Yielding Moment My

Calculation of θ_y and My according to Annex 7 -

 θ_y = Min(θ_{y_ten}, θ_{y_com})

y_ten = 5.7839606E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^ 2/3) = 296.8901
    d = 357.00
     y = 0.28109378
    A = 0.01888488
    B = 0.01064174
     with pt = 0.00680079
        pc = 0.00796398
        pv = 0.00281599
        N = 5974.527
        b = 400.00
         " = 0.12044818
 y_comp = 2.3130541E-005
with fc* (12.3, (ACI 440)) = 34.65043
    fc = 33.00
    fl = 0.93147527
    b = 400.00
    h = 400.00
    Ag = 160000.00
    From (12.9), ACI 440: ka = 0.56518315
      g = pt + pc + pv = 0.01874396
     rc = 40.00
     Ae/Ac = 0.56518315
     Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
    effective strain from (12.5) and (12.12), efe = 0.004
     fu = 0.01
   Ef = 64828.00
   Ec = 26999.444
    y = 0.27975145
   A = 0.0186534
   B = 0.01050082
    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 = 0.042
with:
- Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
  shear control ratio VyE/VColOE = 0.18171192
  d = d_external = 357.00
  s = s_external = 0.00
   t = s1 + s2 + 2*tf/bw*(ffe/fs) = 0.00680079
  jacket: s1 = Av1*h1/(s1*Ag) = 0.00392699
      Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
      h1 = 400.00
      s1 = 100.00
  core: s2 = Av2*h2/(s2*Ag) = 0.00050265
      Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
      h2 = 200.00
      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 = 5974.527
   Ag = 160000.00
   f'cE = (fc_jacket*Area_jacket+ fc_core*Area_core)/section_area = 29.75
   fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+ fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein =
529.9948
   fytE = (fy_ext_Trans_Reinf*Area_ext_Trans_Reinf+ fy_int_Trans_Reinf*Area_int_Trans_Reinf)/Area_Tot_Trans_Rein =

542.9472
pl = Area_Tot_Long_Rein/(b*d) = 0.01874396
  b = 400.00
  d = 357.00
    f'cE = 29.75

End Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 2
Integration Section: (a)

Calculation No. 11

column C1, Floor 1

Limit State: Collapse Prevention (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 JC1 of floor 1
At local axis: 3
Integration Section: (a)
Section Type: rcjrs

Constant Properties

Knowledge Factor,   = 0.85
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
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of y for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, 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 = 555.5556
Existing Column
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.4444
##
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups 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
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
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 = -2.1377975E-010
Shear Force, Va = 1.1783778E-013
EDGE -B-
Bending Moment, Mb = -1.3974459E-010
Shear Force, Vb = -1.1783778E-013
BOTH EDGES
Axial Force, F = -5974.527
Longitudinal Reinforcement Area Distribution (in 2 divisions)
       -Tension: Aslt = 1137.257
     -Compression: Aslc = 1539.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
       -Tension: Asl,ten = 1137.257
     -Compression: Asl,com = 1137.257
         -Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL,ten = 16.80

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR =   *Vn = 475023.398
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 558851.057
  VCol = 558851.057
  knl = 1.00

displacement_ductility_demand = 0.00

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 = 22.75, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
     Mu = 2.1377975E-010
     Vu = 1.1783778E-013
  d = 0.8*h = 320.00
  Nu = 5974.527
  Ag = 160000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 251327.412
  where:
  Vs1 = 251327.412 is calculated for jacket, with:
    d = 320.00
    Av = 157079.633
    fy = 500.00
    s = 100.00
  Vs1 is multiplied by   Col1 = 1.00
    s/d = 0.3125
  Vs2 = 0.00 is calculated for core, with:
    d = 160.00
    Av = 100530.965
    fy = 400.00
    s = 250.00
  Vs2 is multiplied by   Col2 = 0.00
    s/d = 1.5625
  Vf ((11-3)-(11.4), ACI 440) = 188111.148
    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 = 1.016
  dfv = d (figure 11.2, ACI 440) = 357.00
  ffe ((11-5), ACI 440) = 259.312
     Ef = 64828.00
      fe = 0.004, from (11.6a), ACI 440
       with   fu = 0.01
   From (11-11), ACI 440: Vs + Vf <= 405571.497
     bw = 400.00

----
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   = 6.4104099E-022
 y = (My*Ls/3)/EIeff = 0.00355215 ((4.29),Biskinis Phd))
  My = 1.2106E+008
  Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
  From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7040E+013
     factor = 0.30
       Ag = 160000.00
       Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 29.75
       N = 5974.527
     Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.6801E+013

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7 -

----

  y = Min(y_ten, y_com)
  y_ten = 5.7839606E-006
  with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 296.8901
      d = 357.00
       y = 0.28109378
      A = 0.01888488
      B = 0.01064174
       with pt = 0.00796398
          pc = 0.00796398
          pv = 0.00281599
          N = 5974.527
          b = 400.00
           " = 0.12044818
  y_comp = 2.3130541E-005
 with fc* (12.3, (ACI 440)) = 34.65043
      fc = 33.00
      fl = 0.93147527
      b = 400.00
      h = 400.00
      Ag = 160000.00
      From (12.9), ACI 440: ka = 0.56518315
          g = pt + pc + pv = 0.01874396
          rc = 40.00
          Ae/Ac = 0.56518315
          Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
       effective strain from (12.5) and (12.12), efe = 0.004
        fu = 0.01
      Ef = 64828.00
      Ec = 26999.444
       y = 0.27975145
      A = 0.0186534
      B = 0.01050082
       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 JC1 of floor 1
At local axis: 3
Integration Section: (a)

Calculation No. 12

column C1, Floor 1

Limit State: Collapse Prevention (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 JC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcjrs

Constant Properties

Knowledge Factor,   = 0.85
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 = 555.5556
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.4444
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556
##
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.13212
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups 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
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
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 = -1.8468314E-031
EDGE -B-
Shear Force, Vb = 1.8468314E-031
BOTH EDGES
Axial Force, F = -5976.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
       -Tension: Aslt = 0.00
     -Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1137.257
     -Compression: Asl,com = 1137.257
        -Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.18171192
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 115036.425
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.7255E+008
   Mu1+ = 1.7255E+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- = 1.7255E+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-) = 1.7255E+008
   Mu2+ = 1.7255E+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- = 1.7255E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
   u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
     N = 5976.808
  fc = 33.00
   co (5A.5, TBDY) = 0.002

Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01608084

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

  From (5.4b), TBDY: cu = 0.01608084

   we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.09892348

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

----

  fx = 0.07683125

   af = 0.57333333

     b = 400.00

     h = 400.00

   From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508

     bw = 400.00

   effective stress from (A.35), ff,e = 870.5244

----

  fy = 0.07683125

   af = 0.57333333

     b = 400.00

     h = 400.00

   From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508

     bw = 400.00

   effective stress from (A.35), ff,e = 870.5244

  R = 40.00

  Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016

  fu,f = 1055.00

  Ef = 64828.00

  u,f = 0.015

  ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288

    ase1 = 0.24250288

      bo_1 = 340.00

      ho_1 = 340.00

       bi2_1 = 462400.00

    ase2 = Max(ase1,ase2) = 0.24250288

      bo_2 = 192.00

      ho_2 = 192.00

       bi2_2 = 147456.00

  psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633

----

  psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633

   ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699

    Ash1 = Astir_1*ns_1 = 157.0796

     No stirups, ns_1 = 2.00

    h1 = 400.00

   ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265

    Ash2 = Astir_2*ns_2 = 100.531

     No stirups, ns_2 = 2.00

    h2 = 200.00

----

  psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633

   ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699

    Ash1 = Astir_1*ns_1 = 157.0796

     No stirups, ns_1 = 2.00

    h1 = 400.00

   ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265

    Ash2 = Astir_2*ns_2 = 100.531

     No stirups, ns_2 = 2.00

    h2 = 200.00

    Asec = 160000.00

    s1 = 100.00

    s2 = 250.00

   fywe1 = 694.4444

   fywe2 = 555.5556

   fce = 33.00

  From ((5.A5), TBDY), TBDY: cc = 0.00332119

    c = confinement factor = 1.13212

y1 = 0.00140044

sh1 = 0.0044814
ft1 = 441.538
fy1 = 367.9484
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 = 367.9484
  with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 441.538
fy2 = 367.9484
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 = 367.9484
  with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.813
fyv = 389.0108
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 = 389.0108
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
cc (5A.5, TBDY) = 0.00332119
  c = confinement factor = 1.13212
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.19835408

Mu = MRc (4.14) = 1.7255E+008
  u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
    N = 5976.808
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: cu = 0.01608084
       we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx,   fy) = 0.09892348
     where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
     ----
       fx = 0.07683125
       af = 0.57333333
          b = 400.00
          h = 400.00
        From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
          bw = 400.00
       effective stress from (A.35), ff,e = 870.5244
     ----
       fy = 0.07683125
       af = 0.57333333
          b = 400.00
          h = 400.00
        From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
          bw = 400.00
       effective stress from (A.35), ff,e = 870.5244

       R = 40.00
       Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
       fu,f = 1055.00
       Ef = 64828.00
        u,f = 0.015
       ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
          ase1 = 0.24250288
             bo_1 = 340.00
             ho_1 = 340.00
               bi2_1 = 462400.00
          ase2 = Max(ase1,ase2) = 0.24250288
             bo_2 = 192.00
             ho_2 = 192.00
               bi2_2 = 147456.00
        psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
     ----
       psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
         ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
             Ash1 = Astir_1*ns_1 = 157.0796

169

No stirups, ns_1 = 2.00
                h1 = 400.00
             ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
                Ash2 = Astir_2*ns_2 = 100.531
                    No stirups, ns_2 = 2.00
                h2 = 200.00
       ----
          psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
             ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
                Ash1 = Astir_1*ns_1 = 157.0796
                    No stirups, ns_1 = 2.00
                h1 = 400.00
             ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
                Ash2 = Astir_2*ns_2 = 100.531
                    No stirups, ns_2 = 2.00
                h2 = 200.00

          Asec = 160000.00
          s1 = 100.00
          s2 = 250.00
        fywe1 = 694.4444
        fywe2 = 555.5556
        fce = 33.00
     From ((5.A5), TBDY), TBDY: cc = 0.00332119
          c = confinement factor = 1.13212
   y1 = 0.00140044
   sh1 = 0.0044814
 ft1 = 441.538
 fy1 = 367.9484
   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 = 367.9484
       with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
   y2 = 0.00140044
   sh2 = 0.0044814
 ft2 = 441.538
 fy2 = 367.9484
   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 = 367.9484
       with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
   yv = 0.00140044
   shv = 0.0044814
 ftv = 466.813
 fyv = 389.0108
   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 ɣv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
ɣy1, 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 = 389.0108
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ρ1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
ρ2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
ρv = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ρ1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
ρ2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
ρv = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
' satisfies Eq. (4.3)
--->
ρv < ρvs,y2 - LHS eq.(4.5) is satisfied
--->
εsu (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
φu = φsu (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
ν = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.01608084
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01608084
ωwe ((5.4c), TBDY) = αse*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.09892348
where ωf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.07683125
αf = 0.57333333
b = 400.00
h = 400.00
From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244

ωfy = 0.07683125

af = 0.57333333
b = 400.00
h = 400.00
From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244

R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
u,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
bi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
bi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.4444
fywe2 = 555.5556
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00332119
c = confinement factor = 1.13212
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 441.538
fy1 = 367.9484
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 = 367.9484
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.00140044
sh2 = 0.0044814
ft2 = 441.538
fy2 = 367.9484
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 = 367.9484
     with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00140044
  shv = 0.0044814
 ftv = 466.813
 fyv = 389.0108
  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 = 389.0108
     with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
    2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
    v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
  b = 340.00
  d = 327.00
  d' = 13.00
  fcc (5A.2, TBDY) = 37.35991
   cc (5A.5, TBDY) = 0.00332119
      c = confinement factor = 1.13212
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
    2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
    v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
  u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

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

```
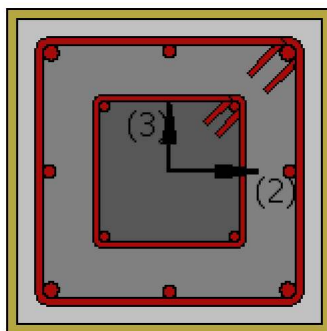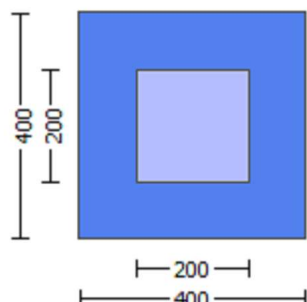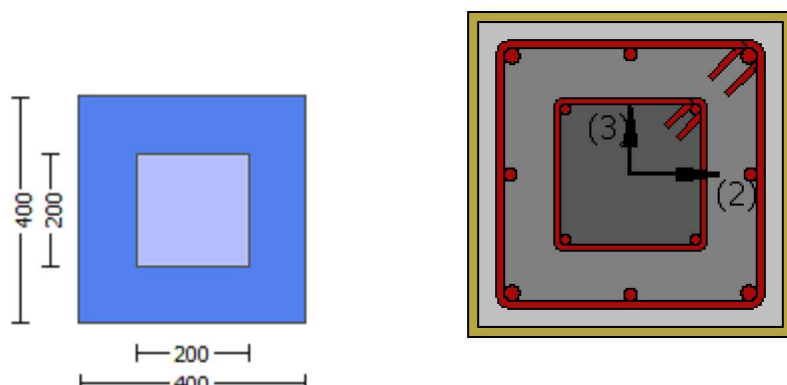   u = 1.7890363E-005
  Mu = 1.7255E+008
  -----------------------------------------------------------------------------
  with full section properties:
    b = 400.00
    d = 357.00
    d' = 43.00
    v = 0.00126831
      N = 5976.808
    fc = 33.00
     co (5A.5, TBDY) = 0.002
    Final value of  cu:  cu* = shear_factor * Max( cu, cc) = 0.01608084
       The Shear_factor is considered equal to 1 (pure moment strength)
       From (5.4b), TBDY:  cu = 0.01608084
         we ((5.4c), TBDY) = ase*  sh,min*fywe/fce+Min(  fx,   fy) = 0.09892348
       where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
       ----------------------------------------------------------------
         fx = 0.07683125
         af = 0.57333333
            b = 400.00
            h = 400.00
          From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
            bw = 400.00
         effective stress from (A.35), ff,e = 870.5244
       ----------------------------------------------------------------
         fy = 0.07683125
         af = 0.57333333
            b = 400.00
            h = 400.00
          From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
            bw = 400.00
         effective stress from (A.35), ff,e = 870.5244
       ----------------------------------------------------------------
         R = 40.00
         Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
         fu,f = 1055.00
         Ef = 64828.00
          u,f = 0.015
         ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
            ase1 = 0.24250288
               bo_1 = 340.00
               ho_1 = 340.00
                bi2_1 = 462400.00
         ase2 = Max(ase1,ase2) = 0.24250288
               bo_2 = 192.00
               ho_2 = 192.00
                bi2_2 = 147456.00
         psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
       ----------------------------------------------------------------
         psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
            ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
               Ash1 = Astir_1*ns_1 = 157.0796
                 No stirups, ns_1 = 2.00
               h1 = 400.00
            ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
               Ash2 = Astir_2*ns_2 = 100.531
                 No stirups, ns_2 = 2.00
               h2 = 200.00
       ----------------------------------------------------------------
         psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
            ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
               Ash1 = Astir_1*ns_1 = 157.0796
                 No stirups, ns_1 = 2.00
               h1 = 400.00
            ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
               Ash2 = Astir_2*ns_2 = 100.531
                 No stirups, ns_2 = 2.00
```

```
                h2 = 200.00
      ----------------------------------------------------------------
              Asec = 160000.00
                s1 = 100.00
                s2 = 250.00
             fywe1 = 694.4444
             fywe2 = 555.5556
               fce = 33.00
        From ((5.A5), TBDY):  cc = 0.00332119
             c  = confinement factor = 1.13212
       y1 = 0.00140044
      sh1 = 0.0044814
     ft1 = 441.538
     fy1 = 367.9484
      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 = 367.9484
          with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
       y2 = 0.00140044
      sh2 = 0.0044814
     ft2 = 441.538
     fy2 = 367.9484
      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 = 367.9484
          with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
      yv = 0.00140044
     shv = 0.0044814
    ftv = 466.813
    fyv = 389.0108
     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 = 389.0108
          with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
      1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
      2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
      v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
  and confined core properties:
    b = 340.00
    d = 327.00
    d' = 13.00
    fcc (5A.2, TBDY) = 37.35991
```

```
     cc (5A.5, TBDY) = 0.00332119
        c = confinement factor = 1.13212
      1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
      2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
      v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
  su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
  u =    su (4.1) = 1.7890363E-005
    -----------------------------------------------------------


Calculation of ratio lb/ld
    -----------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
    ---------------------------------------------------------------------
    ---------------------------------------------------------------------
    ---------------------------------------------------------------------
    ---------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 633070.334
    ---------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 633070.334
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 633070.334
  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 = 29.75, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
   M/Vd = 2.00
      Mu = 8.4878329E-012
      Vu = 1.8468314E-031
    d = 0.8*h = 320.00
    Nu = 5976.808
    Ag = 160000.00
    From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279252.68
    where:
    Vs1 = 279252.68 is calculated for jacket, with:
       d = 320.00
       Av = 157079.633
       fy = 555.5556
       s = 100.00
    Vs1 is multiplied by   Col1 = 1.00
       s/d = 0.3125
    Vs2 = 0.00 is calculated for core, with:
       d = 160.00
       Av = 100530.965
       fy = 444.4444
       s = 250.00
    Vs2 is multiplied by   Col2 = 0.00
       s/d = 1.5625
    Vf ((11-3)-(11.4), ACI 440) = 188111.148
       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 = 1.016
```

dfv = d (figure 11.2, ACI 440) = 357.00
    ffe ((11-5), ACI 440) = 259.312
       Ef = 64828.00
        fe = 0.004, from (11.6a), ACI 440
          with fu = 0.01
    From (11-11), ACI 440: Vs + Vf <= 463788.751
       bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 633070.334
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
   VCol0 = 633070.334
   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 = 29.75, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
   M/Vd = 2.00
      Mu = 8.4878329E-012
      Vu = 1.8468314E-031
    d = 0.8*h = 320.00
    Nu = 5976.808
    Ag = 160000.00
    From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279252.68
    where:
    Vs1 = 279252.68 is calculated for jacket, with:
      d = 320.00
      Av = 157079.633
      fy = 555.5556
      s = 100.00
    Vs1 is multiplied by Col1 = 1.00
      s/d = 0.3125
    Vs2 = 0.00 is calculated for core, with:
      d = 160.00
      Av = 100530.965
      fy = 444.4444
      s = 250.00
    Vs2 is multiplied by Col2 = 0.00
      s/d = 1.5625
    Vf ((11-3)-(11.4), ACI 440) = 188111.148
      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 = 1.016
    dfv = d (figure 11.2, ACI 440) = 357.00
    ffe ((11-5), ACI 440) = 259.312
       Ef = 64828.00
        fe = 0.004, from (11.6a), ACI 440
          with fu = 0.01
    From (11-11), ACI 440: Vs + Vf <= 463788.751
       bw = 400.00

End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjrs

Constant Properties

Knowledge Factor,   = 0.85
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 = 555.5556
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.4444
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556
###
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.13212
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups 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
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
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 = 3.2548216E-032
EDGE -B-
Shear Force, Vb = -3.2548216E-032
BOTH EDGES
Axial Force, F = -5976.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
    -Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: Asl,ten = 1137.257
       -Compression: Asl,com = 1137.257
          -Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.18171192
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 115036.425
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.7255E+008
   Mu1+ = 1.7255E+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- = 1.7255E+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-) = 1.7255E+008
   Mu2+ = 1.7255E+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- = 1.7255E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
   u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
   b = 400.00
   d = 357.00
   d' = 43.00
   v = 0.00126831
     N = 5976.808
   fc = 33.00
    co (5A.5, TBDY) = 0.002
   Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
      The Shear_factor is considered equal to 1 (pure moment strength)
      From (5.4b), TBDY: cu = 0.01608084
        we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx,   fy) = 0.09892348
      where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
      ----
        fx = 0.07683125
        af = 0.57333333
           b = 400.00
           h = 400.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
           bw = 400.00
        effective stress from (A.35), ff,e = 870.5244
      ----
        fy = 0.07683125
        af = 0.57333333
           b = 400.00
           h = 400.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
           bw = 400.00
        effective stress from (A.35), ff,e = 870.5244

        R = 40.00
        Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
        fu,f = 1055.00
        Ef = 64828.00
         u,f = 0.015
        ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288

ase1 = 0.24250288
                    bo_1 = 340.00
                    ho_1 = 340.00
                     bi2_1 = 462400.00
            ase2 = Max(ase1,ase2) = 0.24250288
                    bo_2 = 192.00
                    ho_2 = 192.00
                     bi2_2 = 147456.00
            psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
        ----
            psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
                ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
                    Ash1 = Astir_1*ns_1 = 157.0796
                        No stirups, ns_1 = 2.00
                    h1 = 400.00
                ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
                    Ash2 = Astir_2*ns_2 = 100.531
                        No stirups, ns_2 = 2.00
                    h2 = 200.00
        ----
            psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
                ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
                    Ash1 = Astir_1*ns_1 = 157.0796
                        No stirups, ns_1 = 2.00
                    h1 = 400.00
                ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
                    Ash2 = Astir_2*ns_2 = 100.531
                        No stirups, ns_2 = 2.00
                    h2 = 200.00

                Asec = 160000.00
                s1 = 100.00
                s2 = 250.00
            fywe1 = 694.4444
            fywe2 = 555.5556
            fce = 33.00
        From ((5.A5), TBDY), TBDY: cc = 0.00332119
            c = confinement factor = 1.13212
     y1 = 0.00140044
     sh1 = 0.0044814
    ft1 = 441.538
    fy1 = 367.9484
     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 = 367.9484
         with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
     y2 = 0.00140044
     sh2 = 0.0044814
    ft2 = 441.538
    fy2 = 367.9484
     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 = 367.9484
  with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
shv = 0.0044814
ftv = 466.813
fyv = 389.0108
suv = 0.00512
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.30
   suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
  From table 5A.1, TBDY: esuv_nominal = 0.08,
  considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
  For calculation of esuv_nominal and εyv, shv,ftv,fyv, it is considered
  characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
  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 = 389.0108
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
 b = 340.00
 d = 327.00
 d' = 13.00
 fcc (5A.2, TBDY) = 37.35991
  εcc (5A.5, TBDY) = 0.00332119
   αc = confinement factor = 1.13212
  ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
  ω2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
  ωv = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
ωv < ωs,y2 - LHS eq.(4.5) is satisfied
--->
εsu (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
 φu = φsu (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
 φu = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
 b = 400.00
 d = 357.00
 d' = 43.00
 ν = 0.00126831
  N = 5976.808
 fc = 33.00
  εco (5A.5, TBDY) = 0.002
 Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.01608084
  The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: cu = 0.01608084
   we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.09892348
  where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
  ----
   fx = 0.07683125
    af = 0.57333333
       b = 400.00
       h = 400.00
   From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
       bw = 400.00
   effective stress from (A.35), ff,e = 870.5244
  ----
   fy = 0.07683125
    af = 0.57333333
       b = 400.00
       h = 400.00
   From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
       bw = 400.00
   effective stress from (A.35), ff,e = 870.5244

   R = 40.00
   Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
   fu,f = 1055.00
   Ef = 64828.00
    u,f = 0.015
   ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
       ase1 = 0.24250288
          bo_1 = 340.00
          ho_1 = 340.00
           bi2_1 = 462400.00
       ase2 = Max(ase1,ase2) = 0.24250288
          bo_2 = 192.00
          ho_2 = 192.00
           bi2_2 = 147456.00
   psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
  ----
   psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
       ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
          Ash1 = Astir_1*ns_1 = 157.0796
             No stirups, ns_1 = 2.00
          h1 = 400.00
       ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
          Ash2 = Astir_2*ns_2 = 100.531
             No stirups, ns_2 = 2.00
          h2 = 200.00
  ----
   psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
       ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
          Ash1 = Astir_1*ns_1 = 157.0796
             No stirups, ns_1 = 2.00
          h1 = 400.00
       ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
          Ash2 = Astir_2*ns_2 = 100.531
             No stirups, ns_2 = 2.00
          h2 = 200.00

        Asec = 160000.00
        s1 = 100.00
        s2 = 250.00
     fywe1 = 694.4444
     fywe2 = 555.5556
     fce = 33.00
   From ((5.A5), TBDY), TBDY: cc = 0.00332119
        c = confinement factor = 1.13212
  y1 = 0.00140044
  sh1 = 0.0044814
ft1 = 441.538

fy1 = 367.9484
 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 = 367.9484
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
 y2 = 0.00140044
 sh2 = 0.0044814
ft2 = 441.538
fy2 = 367.9484
 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 = 367.9484
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
 yv = 0.00140044
 shv = 0.0044814
ftv = 466.813
fyv = 389.0108
 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 = 389.0108
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
   2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
   v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
  b = 340.00
  d = 327.00
  d' = 13.00
  fcc (5A.2, TBDY) = 37.35991
   cc (5A.5, TBDY) = 0.00332119
     c = confinement factor = 1.13212
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
   2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
   v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
 u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
  u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
    N = 5976.808
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.01608084
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.09892348
    where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
      ----
      fx = 0.07683125
      af = 0.57333333
         b = 400.00
         h = 400.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
         bw = 400.00
      effective stress from (A.35), ff,e = 870.5244
      ----
      fy = 0.07683125
      af = 0.57333333
         b = 400.00
         h = 400.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
         bw = 400.00
      effective stress from (A.35), ff,e = 870.5244

      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
      fu,f = 1055.00
      Ef = 64828.00
       u,f = 0.015
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
         ase1 = 0.24250288
            bo_1 = 340.00
            ho_1 = 340.00
             bi2_1 = 462400.00
         ase2 = Max(ase1,ase2) = 0.24250288
            bo_2 = 192.00
            ho_2 = 192.00
             bi2_2 = 147456.00
      psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
      ----
      psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
         ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
            Ash1 = Astir_1*ns_1 = 157.0796
              No stirups, ns_1 = 2.00
            h1 = 400.00

```
        ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
            Ash2 = Astir_2*ns_2 = 100.531
                No stirups, ns_2 = 2.00
            h2 = 200.00
     ----------------------------------------------------------------
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
            ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
                Ash1 = Astir_1*ns_1 = 157.0796
                    No stirups, ns_1 = 2.00
                h1 = 400.00
            ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
                Ash2 = Astir_2*ns_2 = 100.531
                    No stirups, ns_2 = 2.00
                h2 = 200.00
     ----------------------------------------------------------------
            Asec = 160000.00
            s1 = 100.00
            s2 = 250.00
        fywe1 = 694.4444
        fywe2 = 555.5556
        fce = 33.00
    From ((5.A5), TBDY), TBDY:  cc = 0.00332119
        c  = confinement factor = 1.13212
  y1 = 0.00140044
  sh1 = 0.0044814
 ft1 = 441.538
 fy1 = 367.9484
  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 = 367.9484
      with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.00140044
  sh2 = 0.0044814
 ft2 = 441.538
 fy2 = 367.9484
  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 = 367.9484
      with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00140044
  shv = 0.0044814
 ftv = 466.813
 fyv = 389.0108
  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 = 389.0108
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
 b = 340.00
 d = 327.00
 d' = 13.00
 fcc (5A.2, TBDY) = 37.35991
  cc (5A.5, TBDY) = 0.00332119
    c = confinement factor = 1.13212
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
   2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
   v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
 u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
 u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
 b = 400.00
 d = 357.00
 d' = 43.00
 v = 0.00126831
   N = 5976.808
 fc = 33.00
  co (5A.5, TBDY) = 0.002
 Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
   The Shear_factor is considered equal to 1 (pure moment strength)
   From (5.4b), TBDY: cu = 0.01608084
    we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx,   fy) = 0.09892348
   where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
   ----
    fx = 0.07683125
    af = 0.57333333
      b = 400.00
      h = 400.00
    From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
      bw = 400.00
    effective stress from (A.35), ff,e = 870.5244
   ----
    fy = 0.07683125
    af = 0.57333333
      b = 400.00

```
        h = 400.00
      From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
        bw = 400.00
      effective stress from (A.35), ff,e = 870.5244
   -------------------------------------------------------------
      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
      fu,f = 1055.00
      Ef = 64828.00
       u,f = 0.015
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
         ase1 = 0.24250288
            bo_1 = 340.00
            ho_1 = 340.00
             bi2_1 = 462400.00
         ase2 = Max(ase1,ase2) = 0.24250288
            bo_2 = 192.00
            ho_2 = 192.00
             bi2_2 = 147456.00
      psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
   -------------------------------------------------------------
      psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
        ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
           Ash1 = Astir_1*ns_1 = 157.0796
              No stirups, ns_1 = 2.00
           h1 = 400.00
        ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
           Ash2 = Astir_2*ns_2 = 100.531
              No stirups, ns_2 = 2.00
           h2 = 200.00
   -------------------------------------------------------------
      psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
        ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
           Ash1 = Astir_1*ns_1 = 157.0796
              No stirups, ns_1 = 2.00
           h1 = 400.00
        ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
           Ash2 = Astir_2*ns_2 = 100.531
              No stirups, ns_2 = 2.00
           h2 = 200.00
   -------------------------------------------------------------
        Asec = 160000.00
        s1 = 100.00
        s2 = 250.00
      fywe1 = 694.4444
      fywe2 = 555.5556
      fce  = 33.00
    From ((5.A5), TBDY), TBDY:  cc = 0.00332119
        c = confinement factor = 1.13212
  y1 = 0.00140044
  sh1 = 0.0044814
 ft1 = 441.538
 fy1 = 367.9484
  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 = 367.9484
     with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.00140044
  sh2 = 0.0044814
```

ft2 = 441.538
fy2 = 367.9484
  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 = 367.9484
      with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00140044
  shv = 0.0044814
 ftv = 466.813
 fyv = 389.0108
  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 = 389.0108
      with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
  2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
  v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
  b = 340.00
  d = 327.00
  d' = 13.00
  fcc (5A.2, TBDY) = 37.35991
   cc (5A.5, TBDY) = 0.00332119
     c = confinement factor = 1.13212
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
    2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
    v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
  u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 633070.334

Calculation of Shear Strength at edge 1, Vr1 = 633070.334
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 633070.334
  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 = 29.75, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
  Mu = 1.4989884E-012
  Vu = 3.2548216E-032
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279252.68
where:
Vs1 = 279252.68 is calculated for jacket, with:
  d = 320.00
  Av = 157079.633
  fy = 555.5556
  s = 100.00
Vs1 is multiplied by Col1 = 1.00
  s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
  d = 160.00
  Av = 100530.965
  fy = 444.4444
  s = 250.00
Vs2 is multiplied by Col2 = 0.00
  s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
  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 = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
  Ef = 64828.00
   εfe = 0.004, from (11.6a), ACI 440
     with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 463788.751
  bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 633070.334
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 633070.334
  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 = 29.75, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
  Mu = 1.4989884E-012
  Vu = 3.2548216E-032
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279252.68
where:

Vs1 = 279252.68 is calculated for jacket, with:
    d = 320.00
    Av = 157079.633
    fy = 555.5556
    s = 100.00
  Vs1 is multiplied by   Col1 = 1.00
    s/d = 0.3125
  Vs2 = 0.00 is calculated for core, with:
    d = 160.00
    Av = 100530.965
    fy = 444.4444
    s = 250.00
  Vs2 is multiplied by   Col2 = 0.00
    s/d = 1.5625
  Vf ((11-3)-(11.4), ACI 440) = 188111.148
    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 = 1.016
  dfv = d (figure 11.2, ACI 440) = 357.00
  ffe ((11-5), ACI 440) = 259.312
    Ef = 64828.00
     fe = 0.004, from (11.6a), ACI 440
       with fu = 0.01
  From (11-11), ACI 440: Vs + Vf <= 463788.751
    bw = 400.00

End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 3
Integration Section: (a)
Section Type: rcjrs

Constant Properties

Knowledge Factor,   = 0.85
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 = 555.5556
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member

Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups 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
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
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 = -1.7103E+007
Shear Force, V2 = -5699.261
Shear Force, V3 = 1.1783778E-013
Axial Force, F = -5974.527
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 1137.257
     -Compression: Aslc = 1539.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1137.257
     -Compression: Asl,com = 1137.257
        -Middle: Asl,mid = 402.1239
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,jacket = 829.3805
     -Compression: Asl,com,jacket = 829.3805
        -Middle: Asl,mid,jacket = 402.1239
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,core = 307.8761
     -Compression: Asl,com,core = 307.8761
        -Middle: Asl,mid,core = 0.00
Mean Diameter of Tension Reinforcement, DbL = 16.80

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity   u,R =   * u = 0.04174045
  u =   y +   p = 0.04910641

 - Calculation of   y -
----
  y = (My*Ls/3)/EIeff = 0.00710641 ((4.29),Biskinis Phd))
  My = 1.2106E+008
  Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3000.891
  From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7040E+013
     factor = 0.30
        Ag = 160000.00
        Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 29.75
        N = 5974.527
     Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.6801E+013

Calculation of Yielding Moment My

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

y_ten = 5.7839606E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 296.8901
    d = 357.00
    y = 0.28109378
    A = 0.01888488
    B = 0.01064174
    with pt = 0.00680079
        pc = 0.00796398
        pv = 0.00281599
        N = 5974.527
        b = 400.00
        " = 0.12044818
  y_comp = 2.3130541E-005
with fc* (12.3, (ACI 440)) = 34.65043
    fc = 33.00
    fl = 0.93147527
    b = 400.00
    h = 400.00
    Ag = 160000.00
    From (12.9), ACI 440: ka = 0.56518315
        g = pt + pc + pv = 0.01874396
        rc = 40.00
        Ae/Ac = 0.56518315
        Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
    effective strain from (12.5) and (12.12), efe = 0.004
        fu = 0.01
    Ef = 64828.00
    Ec = 26999.444
    y = 0.27975145
    A = 0.0186534
    B = 0.01050082
    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 = 0.042
with:
- Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
  shear control ratio VyE/VColOE = 0.18171192
  d = d_external = 357.00
  s = s_external = 0.00
   t = s1 + s2 + 2*tf/bw*(ffe/fs) = 0.00680079
  jacket: s1 = Av1*h1/(s1*Ag) = 0.00392699
        Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
        h1 = 400.00
        s1 = 100.00
  core: s2 = Av2*h2/(s2*Ag) = 0.00050265
        Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
        h2 = 200.00
        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 = 5974.527
    Ag = 160000.00
    f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 29.75
    fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein =
529.9948
    fytE = (fy_ext_Trans_Reinf*Area_ext_Trans_Reinf+fy_int_Trans_Reinf*Area_int_Trans_Reinf)/Area_Tot_Trans_Rein =

542.9472
pl = Area_Tot_Long_Rein/(b*d) = 0.01874396
  b = 400.00
  d = 357.00
  f'cE = 29.75

End Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 3
Integration Section: (a)

Calculation No. 13

column C1, Floor 1

Limit State: Collapse Prevention (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 JC1 of floor 1
At local axis: 2
Integration Section: (b)
Section Type: rcjrs

Constant Properties

Knowledge Factor, = 0.85
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
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of y for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, 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 = 555.5556
Existing Column
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.4444
##
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups 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
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
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 = -1.7103E+007
Shear Force, Va = -5699.261
EDGE -B-
Bending Moment, Mb = 0.05279463
Shear Force, Vb = 5699.261
BOTH EDGES
Axial Force, F = -5974.527
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1137.257
     -Compression: Asl,com = 1137.257
         -Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL,ten = 16.80

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR =   *Vn = 475023.398
Vn ((10.3), ASCE 41-17) = knl*VColO = 558851.057
   VCol = 558851.057
   knl = 1.00

```
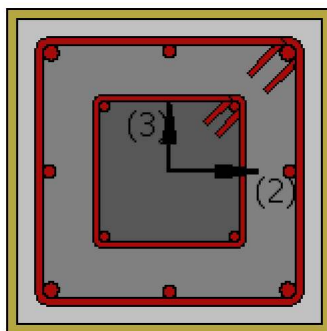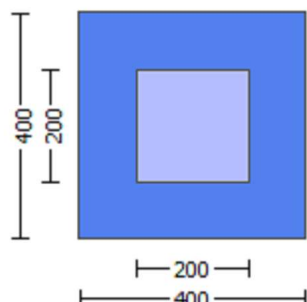       displacement_ductility_demand = 0.21189178
    ------------------------------------------------------------
    NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+  f*Vf'
    where Vf is the contribution of FRPs (11.3), ACI 440).
    ------------------------------------------------------------
        = 1 (normal-weight concrete)
      Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 22.75, but fc^0.5 <= 8.3
    MPa (22.5.3.1, ACI 318-14)
      M/Vd = 2.00
        Mu = 0.05279463
        Vu = 5699.261
      d = 0.8*h = 320.00
      Nu = 5974.527
      Ag = 160000.00
      From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 251327.412
      where:
      Vs1 = 251327.412 is calculated for jacket, with:
        d = 320.00
        Av = 157079.633
        fy = 500.00
        s = 100.00
      Vs1 is multiplied by   Col1 = 1.00
        s/d = 0.3125
      Vs2 = 0.00 is calculated for core, with:
        d = 160.00
        Av = 100530.965
        fy = 400.00
        s = 250.00
      Vs2 is multiplied by   Col2 = 0.00
        s/d = 1.5625
      Vf ((11-3)-(11.4), ACI 440) = 188111.148
        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 = 1.016
      dfv = d (figure 11.2, ACI 440) = 357.00
      ffe ((11-5), ACI 440) = 259.312
        Ef = 64828.00
         fe = 0.004, from (11.6a), ACI 440
           with  fu = 0.01
      From (11-11), ACI 440: Vs + Vf <= 405571.497
        bw = 400.00
    ------------------------------------------------------------

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

     - Calculation of   /  y for END B -
     for rotation axis 3 and integ. section (b)
    ------------------------------------------------------------
    From analysis, chord rotation    = 0.00015053
      y = (My*Ls/3)/EIeff = 0.00071043 ((4.29),Biskinis Phd))
      My = 1.2106E+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 = 1.7040E+013
        factor = 0.30
          Ag = 160000.00
          Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 29.75
          N = 5974.527
        Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.6801E+013
    ------------------------------------------------------------

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

Calculation of Yielding Moment My

Calculation of   y and My according to Annex 7   -
----
  y = Min(y_ten, y_com)
  y_ten = 5.7839606E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 296.8901
    d = 357.00
     y = 0.28109378
    A = 0.01888488
    B = 0.01064174
     with pt = 0.00796398
        pc = 0.00796398
        pv = 0.00281599
        N = 5974.527
        b = 400.00
         " = 0.12044818
  y_comp = 2.3130541E-005
 with fc* (12.3, (ACI 440)) = 34.65043
    fc = 33.00
    fl = 0.93147527
    b = 400.00
    h = 400.00
    Ag = 160000.00
    From (12.9), ACI 440: ka = 0.56518315
        g = pt + pc + pv = 0.01874396
      rc = 40.00
      Ae/Ac = 0.56518315
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
    effective strain from (12.5) and (12.12), efe = 0.004
     fu = 0.01
    Ef = 64828.00
   Ec = 26999.444
    y = 0.27975145
   A = 0.0186534
   B = 0.01050082
    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 JC1 of floor 1
At local axis: 2
Integration Section: (b)

Calculation No. 14

column C1, Floor 1

Limit State: Collapse Prevention (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 JC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcjrs

Constant Properties

Knowledge Factor,   = 0.85
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 = 555.5556
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.4444
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556
##
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.13212
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups 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
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
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 = -1.8468314E-031
EDGE -B-
Shear Force, Vb = 1.8468314E-031
BOTH EDGES
Axial Force, F = -5976.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
       -Tension: Aslt = 0.00
    -Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
       -Tension: Asl,ten = 1137.257
     -Compression: Asl,com = 1137.257
        -Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.18171192
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 115036.425
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.7255E+008
   Mu1+ = 1.7255E+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- = 1.7255E+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-) = 1.7255E+008
   Mu2+ = 1.7255E+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- = 1.7255E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
   u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
   b = 400.00
   d = 357.00
   d' = 43.00
   v = 0.00126831
      N = 5976.808
   fc = 33.00
     co (5A.5, TBDY) = 0.002

Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
  The Shear_factor is considered equal to 1 (pure moment strength)
  From (5.4b), TBDY: cu = 0.01608084
    we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.09892348
  where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
  ----
    fx = 0.07683125
    af = 0.57333333
      b = 400.00
      h = 400.00
    From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
      bw = 400.00
    effective stress from (A.35), ff,e = 870.5244
  ----
    fy = 0.07683125
    af = 0.57333333
      b = 400.00
      h = 400.00
    From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
      bw = 400.00
    effective stress from (A.35), ff,e = 870.5244

    R = 40.00
    Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
    fu,f = 1055.00
    Ef = 64828.00
     u,f = 0.015
    ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
      ase1 = 0.24250288
        bo_1 = 340.00
        ho_1 = 340.00
         bi2_1 = 462400.00
      ase2 = Max(ase1,ase2) = 0.24250288
        bo_2 = 192.00
        ho_2 = 192.00
         bi2_2 = 147456.00
    psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
  ----
    psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
      ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
        Ash1 = Astir_1*ns_1 = 157.0796
          No stirups, ns_1 = 2.00
        h1 = 400.00
      ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
        Ash2 = Astir_2*ns_2 = 100.531
          No stirups, ns_2 = 2.00
        h2 = 200.00
  ----
    psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
      ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
        Ash1 = Astir_1*ns_1 = 157.0796
          No stirups, ns_1 = 2.00
        h1 = 400.00
      ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
        Ash2 = Astir_2*ns_2 = 100.531
          No stirups, ns_2 = 2.00
        h2 = 200.00

      Asec = 160000.00
      s1 = 100.00
      s2 = 250.00
    fywe1 = 694.4444
    fywe2 = 555.5556
    fce = 33.00
  From ((5.A5), TBDY), TBDY: cc = 0.00332119
    c = confinement factor = 1.13212
y1 = 0.00140044

sh1 = 0.0044814
ft1 = 441.538
fy1 = 367.9484
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 = 367.9484
  with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 441.538
fy2 = 367.9484
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 = 367.9484
  with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.813
fyv = 389.0108
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 = 389.0108
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
cc (5A.5, TBDY) = 0.00332119
  c = confinement factor = 1.13212
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.19835408

Mu = MRc (4.14) = 1.7255E+008
  u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
    N = 5976.808
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of   cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: cu = 0.01608084
       we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.09892348
     where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
     ----
       fx = 0.07683125
        af = 0.57333333
          b = 400.00
          h = 400.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
           bw = 400.00
        effective stress from (A.35), ff,e = 870.5244
     ----
       fy = 0.07683125
        af = 0.57333333
          b = 400.00
          h = 400.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
           bw = 400.00
        effective stress from (A.35), ff,e = 870.5244

       R = 40.00
       Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
       fu,f = 1055.00
       Ef = 64828.00
        u,f = 0.015
       ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
          ase1 = 0.24250288
             bo_1 = 340.00
             ho_1 = 340.00
               bi2_1 = 462400.00
          ase2 = Max(ase1,ase2) = 0.24250288
               bo_2 = 192.00
               ho_2 = 192.00
                 bi2_2 = 147456.00
        psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
     ----
        psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
          ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
             Ash1 = Astir_1*ns_1 = 157.0796

No stirups, ns_1 = 2.00
                    h1 = 400.00
                ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
                    Ash2 = Astir_2*ns_2 = 100.531
                        No stirups, ns_2 = 2.00
                    h2 = 200.00
        ----
            psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
                ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
                    Ash1 = Astir_1*ns_1 = 157.0796
                        No stirups, ns_1 = 2.00
                    h1 = 400.00
                ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
                    Ash2 = Astir_2*ns_2 = 100.531
                        No stirups, ns_2 = 2.00
                    h2 = 200.00

            Asec = 160000.00
            s1 = 100.00
            s2 = 250.00
        fywe1 = 694.4444
        fywe2 = 555.5556
        fce = 33.00
    From ((5.A5), TBDY), TBDY: cc = 0.00332119
        c = confinement factor = 1.13212
  y1 = 0.00140044
  sh1 = 0.0044814
 ft1 = 441.538
 fy1 = 367.9484
  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 = 367.9484
      with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.00140044
  sh2 = 0.0044814
 ft2 = 441.538
 fy2 = 367.9484
  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 = 367.9484
      with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00140044
  shv = 0.0044814
 ftv = 466.813
 fyv = 389.0108
  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 = 389.0108
 with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
 2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
 v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
 b = 340.00
 d = 327.00
 d' = 13.00
 fcc (5A.2, TBDY) = 37.35991
  cc (5A.5, TBDY) = 0.00332119
     c = confinement factor = 1.13212
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
 2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
 v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
 u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
 u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
 b = 400.00
 d = 357.00
 d' = 43.00
 v = 0.00126831
    N = 5976.808
 fc = 33.00
  co (5A.5, TBDY) = 0.002
 Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.01608084
     we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx,   fy) = 0.09892348
    where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----
     fx = 0.07683125
      af = 0.57333333
         b = 400.00
         h = 400.00
       From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
         bw = 400.00
      effective stress from (A.35), ff,e = 870.5244
    ----
     fy = 0.07683125

```
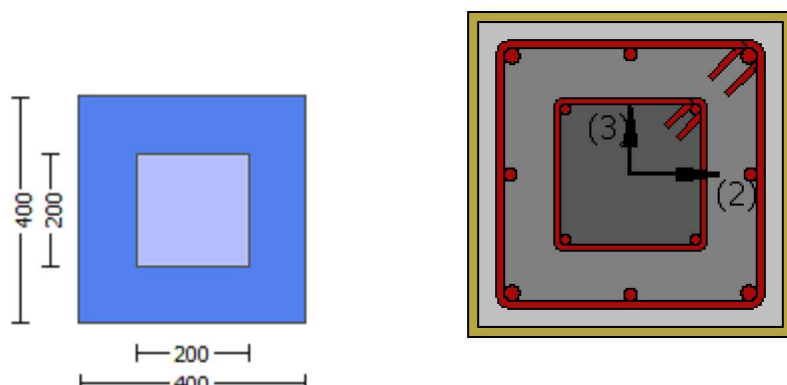        af = 0.57333333
         b = 400.00
         h = 400.00
      From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
         bw = 400.00
      effective stress from (A.35), ff,e = 870.5244
   --------------------------------------------------------------------
      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
      fu,f = 1055.00
      Ef = 64828.00
       u,f = 0.015
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
         ase1 = 0.24250288
            bo_1 = 340.00
            ho_1 = 340.00
             bi2_1 = 462400.00
         ase2 = Max(ase1,ase2) = 0.24250288
            bo_2 = 192.00
            ho_2 = 192.00
             bi2_2 = 147456.00
      psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
   ---------------------------------------------------------------
      psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
         ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
            Ash1 = Astir_1*ns_1 = 157.0796
               No stirups, ns_1 = 2.00
            h1 = 400.00
         ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
            Ash2 = Astir_2*ns_2 = 100.531
               No stirups, ns_2 = 2.00
            h2 = 200.00
   ---------------------------------------------------------------
      psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
         ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
            Ash1 = Astir_1*ns_1 = 157.0796
               No stirups, ns_1 = 2.00
            h1 = 400.00
         ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
            Ash2 = Astir_2*ns_2 = 100.531
               No stirups, ns_2 = 2.00
            h2 = 200.00
   ---------------------------------------------------------------
         Asec = 160000.00
         s1 = 100.00
         s2 = 250.00
      fywe1 = 694.4444
      fywe2 = 555.5556
      fce  = 33.00
   From ((5.A5), TBDY), TBDY:  cc = 0.00332119
        c = confinement factor = 1.13212
  y1 = 0.00140044
 sh1 = 0.0044814
ft1 = 441.538
fy1 = 367.9484
 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 = 367.9484
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
```

y2 = 0.00140044
sh2 = 0.0044814
ft2 = 441.538
fy2 = 367.9484
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 = 367.9484
   with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.813
fyv = 389.0108
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 = 389.0108
   with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
  2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
  v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
 b = 340.00
 d = 327.00
 d' = 13.00
 fcc (5A.2, TBDY) = 37.35991
  cc (5A.5, TBDY) = 0.00332119
    c = confinement factor = 1.13212
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
   2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
   v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
  u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

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

```
   u = 1.7890363E-005
Mu = 1.7255E+008
----------------------------------------------------------------------------
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
     N = 5976.808
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of  cu:  cu* = shear_factor * Max( cu, cc) = 0.01608084
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY:  cu = 0.01608084
        we ((5.4c), TBDY) = ase*  sh,min*fywe/fce+Min(  fx,   fy) = 0.09892348
     where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
     ----------------------------------------------------------------------
        fx = 0.07683125
         af = 0.57333333
            b = 400.00
            h = 400.00
         From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
            bw = 400.00
         effective stress from (A.35), ff,e = 870.5244
     ----------------------------------------------------------------------
        fy = 0.07683125
         af = 0.57333333
            b = 400.00
            h = 400.00
         From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
            bw = 400.00
         effective stress from (A.35), ff,e = 870.5244
     ----------------------------------------------------------------------
        R = 40.00
        Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
        fu,f = 1055.00
        Ef = 64828.00
         u,f = 0.015
        ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
           ase1 = 0.24250288
              bo_1 = 340.00
              ho_1 = 340.00
               bi2_1 = 462400.00
        ase2 = Max(ase1,ase2) = 0.24250288
              bo_2 = 192.00
              ho_2 = 192.00
               bi2_2 = 147456.00
        psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
     ----------------------------------------------------------------------
        psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
           ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
              Ash1 = Astir_1*ns_1 = 157.0796
                 No stirups, ns_1 = 2.00
              h1 = 400.00
           ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
              Ash2 = Astir_2*ns_2 = 100.531
                 No stirups, ns_2 = 2.00
              h2 = 200.00
     ----------------------------------------------------------------------
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
           ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
              Ash1 = Astir_1*ns_1 = 157.0796
                 No stirups, ns_1 = 2.00
              h1 = 400.00
           ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
              Ash2 = Astir_2*ns_2 = 100.531
                 No stirups, ns_2 = 2.00
```

```
            h2 = 200.00
      ----------------------------------------------------------------
          Asec = 160000.00
            s1 = 100.00
            s2 = 250.00
        fywe1 = 694.4444
        fywe2 = 555.5556
          fce  = 33.00
      From ((5.A.5), TBDY), TBDY:  cc = 0.00332119
            c  = confinement factor = 1.13212
    y1 = 0.00140044
   sh1 = 0.0044814
 ft1 = 441.538
 fy1 = 367.9484
  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 = 367.9484
       with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
    y2 = 0.00140044
   sh2 = 0.0044814
 ft2 = 441.538
 fy2 = 367.9484
  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 = 367.9484
       with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
    yv = 0.00140044
   shv = 0.0044814
 ftv = 466.813
 fyv = 389.0108
  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 = 389.0108
       with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
    2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
    v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
  b = 340.00
  d = 327.00
  d' = 13.00
  fcc (5A.2, TBDY) = 37.35991
```

```
   cc (5A.5, TBDY) = 0.00332119
      c = confinement factor = 1.13212
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
    2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
    v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
  u =   su (4.1) = 1.7890363E-005
-------------------------------------------------------------

Calculation of ratio lb/ld
-------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
------------------------------------------------------------------
------------------------------------------------------------------
------------------------------------------------------------------
------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 633070.334
------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 633070.334
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 633070.334
  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 = 29.75, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
     Mu = 8.4878329E-012
     Vu = 1.8468314E-031
  d = 0.8*h = 320.00
  Nu = 5976.808
  Ag = 160000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279252.68
  where:
  Vs1 = 279252.68 is calculated for jacket, with:
     d = 320.00
     Av = 157079.633
     fy = 555.5556
     s = 100.00
  Vs1 is multiplied by   Col1 = 1.00
     s/d = 0.3125
  Vs2 = 0.00 is calculated for core, with:
     d = 160.00
     Av = 100530.965
     fy = 444.4444
     s = 250.00
  Vs2 is multiplied by   Col2 = 0.00
     s/d = 1.5625
  Vf ((11-3)-(11.4), ACI 440) = 188111.148
     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 = 1.016
```

dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
   Ef = 64828.00
    fe = 0.004, from (11.6a), ACI 440
      with fu = 0.01
  From (11-11), ACI 440: Vs + Vf <= 463788.751
    bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 633070.334
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 633070.334
  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 = 29.75, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
    Mu = 8.4878329E-012
    Vu = 1.8468314E-031
  d = 0.8*h = 320.00
  Nu = 5976.808
  Ag = 160000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279252.68
  where:
  Vs1 = 279252.68 is calculated for jacket, with:
   d = 320.00
   Av = 157079.633
   fy = 555.5556
   s = 100.00
  Vs1 is multiplied by Col1 = 1.00
    s/d = 0.3125
  Vs2 = 0.00 is calculated for core, with:
   d = 160.00
   Av = 100530.965
   fy = 444.4444
   s = 250.00
  Vs2 is multiplied by Col2 = 0.00
    s/d = 1.5625
  Vf ((11-3)-(11.4), ACI 440) = 188111.148
    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 = 1.016
  dfv = d (figure 11.2, ACI 440) = 357.00
  ffe ((11-5), ACI 440) = 259.312
    Ef = 64828.00
     fe = 0.004, from (11.6a), ACI 440
       with fu = 0.01
  From (11-11), ACI 440: Vs + Vf <= 463788.751
    bw = 400.00

End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjrs

Constant Properties

Knowledge Factor,   = 0.85
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 = 555.5556
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.4444
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556
###
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.13212
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups 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
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
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 = 3.2548216E-032
EDGE -B-
Shear Force, Vb = -3.2548216E-032
BOTH EDGES
Axial Force, F = -5976.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: Asl,ten = 1137.257
        -Compression: Asl,com = 1137.257
            -Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.18171192
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 115036.425
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.7255E+008
   Mu1+ = 1.7255E+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- = 1.7255E+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-) = 1.7255E+008
   Mu2+ = 1.7255E+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- = 1.7255E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  ν = 0.00126831
     N = 5976.808
  fc = 33.00
   εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.01608084
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: εcu = 0.01608084
       ωwe ((5.4c), TBDY) = αse*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.09892348
     where ωf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

       ωfx = 0.07683125
       αf = 0.57333333
          b = 400.00
          h = 400.00
        From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00508
          bw = 400.00
       effective stress from (A.35), ff,e = 870.5244

       ωfy = 0.07683125
       αf = 0.57333333
          b = 400.00
          h = 400.00
        From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00508
          bw = 400.00
       effective stress from (A.35), ff,e = 870.5244

       R = 40.00
       Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
       fu,f = 1055.00
       Ef = 64828.00
        εu,f = 0.015
       αse ((5.4d), TBDY) = (αse1*Aext+αse2*Aint)/Asec = 0.24250288

```
        ase1 = 0.24250288
             bo_1 = 340.00
             ho_1 = 340.00
              bi2_1 = 462400.00
       ase2 = Max(ase1,ase2) = 0.24250288
             bo_2 = 192.00
             ho_2 = 192.00
              bi2_2 = 147456.00
       psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
     ---------------------------------------------------------------
       psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
          ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
             Ash1 = Astir_1*ns_1 = 157.0796
                No stirups, ns_1 = 2.00
             h1 = 400.00
          ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
             Ash2 = Astir_2*ns_2 = 100.531
                No stirups, ns_2 = 2.00
             h2 = 200.00
     ---------------------------------------------------------------
       psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
          ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
             Ash1 = Astir_1*ns_1 = 157.0796
                No stirups, ns_1 = 2.00
             h1 = 400.00
          ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
             Ash2 = Astir_2*ns_2 = 100.531
                No stirups, ns_2 = 2.00
             h2 = 200.00
     ---------------------------------------------------------------
          Asec = 160000.00
          s1 = 100.00
          s2 = 250.00
        fywe1 = 694.4444
        fywe2 = 555.5556
        fce  = 33.00
     From ((5.A5), TBDY), TBDY:  cc = 0.00332119
          c  = confinement factor = 1.13212
   y1 = 0.00140044
  sh1 = 0.0044814
 ft1 = 441.538
 fy1 = 367.9484
  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 = 367.9484
     with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
   y2 = 0.00140044
  sh2 = 0.0044814
 ft2 = 441.538
 fy2 = 367.9484
  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 = 367.9484
  with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
 yv = 0.00140044
 shv = 0.0044814
ftv = 466.813
fyv = 389.0108
 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 = 389.0108
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
 2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
 v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
 b = 340.00
 d = 327.00
 d' = 13.00
 fcc (5A.2, TBDY) = 37.35991
  cc (5A.5, TBDY) = 0.00332119
   c = confinement factor = 1.13212
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
  2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
  v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
 u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
 u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
 b = 400.00
 d = 357.00
 d' = 43.00
 v = 0.00126831
  N = 5976.808
 fc = 33.00
  co (5A.5, TBDY) = 0.002
 Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
  The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: cu = 0.01608084
  we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.09892348
where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----
  fx = 0.07683125
  af = 0.57333333
    b = 400.00
    h = 400.00
  From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
    bw = 400.00
  effective stress from (A.35), ff,e = 870.5244
----
  fy = 0.07683125
  af = 0.57333333
    b = 400.00
    h = 400.00
  From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
    bw = 400.00
  effective stress from (A.35), ff,e = 870.5244

  R = 40.00
  Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
  fu,f = 1055.00
  Ef = 64828.00
  u,f = 0.015
  ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
    ase1 = 0.24250288
      bo_1 = 340.00
      ho_1 = 340.00
      bi2_1 = 462400.00
    ase2 = Max(ase1,ase2) = 0.24250288
      bo_2 = 192.00
      ho_2 = 192.00
      bi2_2 = 147456.00
  psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
----
  psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
    ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
      Ash1 = Astir_1*ns_1 = 157.0796
        No stirups, ns_1 = 2.00
      h1 = 400.00
    ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
      Ash2 = Astir_2*ns_2 = 100.531
        No stirups, ns_2 = 2.00
      h2 = 200.00
----
  psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
    ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
      Ash1 = Astir_1*ns_1 = 157.0796
        No stirups, ns_1 = 2.00
      h1 = 400.00
    ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
      Ash2 = Astir_2*ns_2 = 100.531
        No stirups, ns_2 = 2.00
      h2 = 200.00

    Asec = 160000.00
    s1 = 100.00
    s2 = 250.00
  fywe1 = 694.4444
  fywe2 = 555.5556
  fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00332119
  c = confinement factor = 1.13212
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 441.538

fy1 = 367.9484
  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 = 367.9484
        with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.00140044
  sh2 = 0.0044814
ft2 = 441.538
fy2 = 367.9484
  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 = 367.9484
        with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00140044
  shv = 0.0044814
ftv = 466.813
fyv = 389.0108
  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 = 389.0108
        with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
    2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
    v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
  b = 340.00
  d = 327.00
  d' = 13.00
  fcc (5A.2, TBDY) = 37.35991
    cc (5A.5, TBDY) = 0.00332119
      c = confinement factor = 1.13212
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
    2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
    v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
  u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  ν = 0.00126831
    N = 5976.808
  fc = 33.00
   εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.01608084
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.01608084
      ωe ((5.4c), TBDY) = αse* ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.09892348
    where ωf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

      ωfx = 0.07683125
      αf = 0.57333333
        b = 400.00
        h = 400.00
      From EC8 A4.4.3(6), ρf = 2tf/bw = 0.00508
        bw = 400.00
      effective stress from (A.35), ff,e = 870.5244

      ωfy = 0.07683125
      αf = 0.57333333
        b = 400.00
        h = 400.00
      From EC8 A4.4.3(6), ρf = 2tf/bw = 0.00508
        bw = 400.00
      effective stress from (A.35), ff,e = 870.5244

      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
      fu,f = 1055.00
      Ef = 64828.00
       εu,f = 0.015
      αse ((5.4d), TBDY) = (αse1*Aext+αse2*Aint)/Asec = 0.24250288
        αse1 = 0.24250288
          bo_1 = 340.00
          ho_1 = 340.00
           bi2_1 = 462400.00
        αse2 = Max(αse1,αse2) = 0.24250288
          bo_2 = 192.00
          ho_2 = 192.00
           bi2_2 = 147456.00
      ρsh,min*Fywe = Min(ρsh,x*Fywe , ρsh,y*Fywe) = 3.00633

      ρsh_x*Fywe = ρsh1*Fywe1+ρs2*Fywe2 = 3.00633
        ρs1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
          Ash1 = Astir_1*ns_1 = 157.0796
            No stirups, ns_1 = 2.00
          h1 = 400.00

```
        ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
            Ash2 = Astir_2*ns_2 = 100.531
                No stirups, ns_2 = 2.00
            h2 = 200.00
     ----------------------------------------------------------------
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
            ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
                Ash1 = Astir_1*ns_1 = 157.0796
                    No stirups, ns_1 = 2.00
                h1 = 400.00
            ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
                Ash2 = Astir_2*ns_2 = 100.531
                    No stirups, ns_2 = 2.00
                h2 = 200.00
     ----------------------------------------------------------------
        Asec = 160000.00
        s1 = 100.00
        s2 = 250.00
      fywe1 = 694.4444
      fywe2 = 555.5556
      fce  = 33.00
  From ((5.A5), TBDY), TBDY:  cc = 0.00332119
        c = confinement factor = 1.13212
  y1 = 0.00140044
  sh1 = 0.0044814
ft1 = 441.538
fy1 = 367.9484
  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 = 367.9484
      with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.00140044
  sh2 = 0.0044814
ft2 = 441.538
fy2 = 367.9484
  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 = 367.9484
      with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00140044
  shv = 0.0044814
ftv = 466.813
fyv = 389.0108
  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 = 389.0108
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
  2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
  v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
  b = 340.00
  d = 327.00
  d' = 13.00
  fcc (5A.2, TBDY) = 37.35991
   cc (5A.5, TBDY) = 0.00332119
     c = confinement factor = 1.13212
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
   2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
   v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
 u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
    N = 5976.808
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of   cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.01608084
     we ((5.4c), TBDY) = ase* sh,min*fywe/fce+ Min(fx,   fy) = 0.09892348
    where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----
      fx = 0.07683125
       af = 0.57333333
         b = 400.00
         h = 400.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
         bw = 400.00
      effective stress from (A.35), ff,e = 870.5244
    ----
      fy = 0.07683125
       af = 0.57333333
         b = 400.00

```
        h = 400.00
     From EC8 A 4.4.3(6), pf = 2tf/bw = 0.00508
        bw = 400.00
     effective stress from (A.35), ff,e = 870.5244
  ------------------------------------------------------------------
     R = 40.00
     Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
     fu,f = 1055.00
     Ef = 64828.00
      u,f = 0.015
     ase ((5.4d), TBDY) = (ase1*Aext+ ase2*Aint)/Asec = 0.24250288
        ase1 = 0.24250288
           bo_1 = 340.00
           ho_1 = 340.00
             bi2_1 = 462400.00
        ase2 = Max(ase1,ase2) = 0.24250288
           bo_2 = 192.00
           ho_2 = 192.00
             bi2_2 = 147456.00
      psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
  ------------------------------------------------------------------
      psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
        ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
           Ash1 = Astir_1*ns_1 = 157.0796
              No stirups, ns_1 = 2.00
           h1 = 400.00
        ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
           Ash2 = Astir_2*ns_2 = 100.531
              No stirups, ns_2 = 2.00
           h2 = 200.00
  ------------------------------------------------------------------
      psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
        ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
           Ash1 = Astir_1*ns_1 = 157.0796
              No stirups, ns_1 = 2.00
           h1 = 400.00
        ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
           Ash2 = Astir_2*ns_2 = 100.531
              No stirups, ns_2 = 2.00
           h2 = 200.00
  ------------------------------------------------------------------
        Asec = 160000.00
        s1 = 100.00
        s2 = 250.00
      fywe1 = 694.4444
      fywe2 = 555.5556
      fce  = 33.00
   From ((5.A5), TBDY), TBDY:  cc = 0.00332119
        c = confinement factor = 1.13212
  y1 = 0.00140044
 sh1 = 0.0044814
ft1 = 441.538
fy1 = 367.9484
 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 = 367.9484
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
 y2 = 0.00140044
 sh2 = 0.0044814
```

ft2 = 441.538
fy2 = 367.9484
  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 = 367.9484
     with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00140044
  shv = 0.0044814
ftv = 466.813
fyv = 389.0108
  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 = 389.0108
     with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
   2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
   v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
  b = 340.00
  d = 327.00
  d' = 13.00
  fcc (5A.2, TBDY) = 37.35991
   cc (5A.5, TBDY) = 0.00332119
      c = confinement factor = 1.13212
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
   2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
   v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
  u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 633070.334

Calculation of Shear Strength at edge 1, Vr1 = 633070.334
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 633070.334
  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 = 29.75, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
    Mu = 1.4989884E-012
    Vu = 3.2548216E-032
  d = 0.8*h = 320.00
  Nu = 5976.808
  Ag = 160000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279252.68
  where:
  Vs1 = 279252.68 is calculated for jacket, with:
    d = 320.00
    Av = 157079.633
    fy = 555.5556
    s = 100.00
  Vs1 is multiplied by  Col1 = 1.00
    s/d = 0.3125
  Vs2 = 0.00 is calculated for core, with:
    d = 160.00
    Av = 100530.965
    fy = 444.4444
    s = 250.00
  Vs2 is multiplied by  Col2 = 0.00
    s/d = 1.5625
  Vf ((11-3)-(11.4), ACI 440) = 188111.148
    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 = 1.016
  dfv = d (figure 11.2, ACI 440) = 357.00
  ffe ((11-5), ACI 440) = 259.312
    Ef = 64828.00
     fe = 0.004, from (11.6a), ACI 440
       with  fu = 0.01
  From (11-11), ACI 440: Vs + Vf <= 463788.751
    bw = 400.00
---------------------------------------------------------------
---------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 633070.334
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 633070.334
  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 = 29.75, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
    Mu = 1.4989884E-012
    Vu = 3.2548216E-032
  d = 0.8*h = 320.00
  Nu = 5976.808
  Ag = 160000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279252.68
  where:
```

Vs1 = 279252.68 is calculated for jacket, with:
   d = 320.00
   Av = 157079.633
   fy = 555.5556
   s = 100.00
 Vs1 is multiplied by   Col1 = 1.00
   s/d = 0.3125
 Vs2 = 0.00 is calculated for core, with:
   d = 160.00
   Av = 100530.965
   fy = 444.4444
   s = 250.00
 Vs2 is multiplied by   Col2 = 0.00
   s/d = 1.5625
 Vf ((11-3)-(11.4), ACI 440) = 188111.148
   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 = 1.016
 dfv = d (figure 11.2, ACI 440) = 357.00
 ffe ((11-5), ACI 440) = 259.312
   Ef = 64828.00
    fe = 0.004, from (11.6a), ACI 440
      with fu = 0.01
 From (11-11), ACI 440: Vs + Vf <= 463788.751
   bw = 400.00

End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 2
Integration Section: (b)
Section Type: rcjrs

Constant Properties

Knowledge Factor,   = 0.85
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 = 555.5556
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member

Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups 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
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
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 = -1.3974459E-010
Shear Force, V2 = 5699.261
Shear Force, V3 = -1.1783778E-013
Axial Force, F = -5974.527
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
      -Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1137.257
      -Compression: Asl,com = 1137.257
         -Middle: Asl,mid = 402.1239
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,jacket = 829.3805
      -Compression: Asl,com,jacket = 829.3805
         -Middle: Asl,mid,jacket = 402.1239
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,core = 307.8761
      -Compression: Asl,com,core = 307.8761
         -Middle: Asl,mid,core = 0.00
Mean Diameter of Tension Reinforcement, DbL = 16.80

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $\theta_{u,R}$ = * θ_u = 0.03871933
 θ_u = θ_y + θ_p = 0.04555215

 - Calculation of θ_y -

 θ_y = (My*Ls/3)/EIeff = 0.00355215 ((4.29),Biskinis Phd))
 My = 1.2106E+008
 Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
 From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7040E+013
    factor = 0.30
       Ag = 160000.00
       Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 29.75
       N = 5974.527
    Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.6801E+013

Calculation of Yielding Moment My

Calculation of θ_y and My according to Annex 7 -

 θ_y = Min(θ_y_ten, θ_y_com)

y_ten = 5.7839606E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 296.8901
   d = 357.00
    y = 0.28109378
   A = 0.01888488
   B = 0.01064174
    with pt = 0.00680079
       pc = 0.00796398
       pv = 0.00281599
       N = 5974.527
       b = 400.00
        " = 0.12044818
 y_comp = 2.3130541E-005
with fc* (12.3, (ACI 440)) = 34.65043
    fc = 33.00
    fl = 0.93147527
    b = 400.00
    h = 400.00
    Ag = 160000.00
    From (12.9), ACI 440: ka = 0.56518315
      g = pt + pc + pv = 0.01874396
     rc = 40.00
     Ae/Ac = 0.56518315
     Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
    effective strain from (12.5) and (12.12), efe = 0.004
     fu = 0.01
   Ef = 64828.00
   Ec = 26999.444
    y = 0.27975145
   A = 0.0186534
   B = 0.01050082
    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 = 0.042
with:
- Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
  shear control ratio VyE/VColOE = 0.18171192
  d = d_external = 357.00
  s = s_external = 0.00
   t =   s1 +   s2 + 2*tf/bw*(ffe/fs) = 0.00680079
  jacket: s1 = Av1*h1/(s1*Ag) = 0.00392699
      Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
      h1 = 400.00
      s1 = 100.00
  core: s2 = Av2*h2/(s2*Ag) = 0.00050265
      Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
      h2 = 200.00
      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 = 5974.527
   Ag = 160000.00
   f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 29.75
   fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein =
529.9948
   fytE = (fy_ext_Trans_Reinf*Area_ext_Trans_Reinf+fy_int_Trans_Reinf*Area_int_Trans_Reinf)/Area_Tot_Trans_Rein =

542.9472
pl = Area_Tot_Long_Rein/(b*d) = 0.01874396
   b = 400.00
   d = 357.00
   f'cE = 29.75

End Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 2
Integration Section: (b)

Calculation No. 15

column C1, Floor 1

Limit State: Collapse Prevention (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 JC1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rcjrs

Constant Properties

Knowledge Factor,   = 0.85
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
Existing material of Primary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Primary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of y for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, 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 = 555.5556
Existing Column
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.4444
###
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups 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
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
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 = -2.1377975E-010
Shear Force, Va = 1.1783778E-013
EDGE -B-
Bending Moment, Mb = -1.3974459E-010
Shear Force, Vb = -1.1783778E-013
BOTH EDGES
Axial Force, F = -5974.527
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
    -Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 1137.257
    -Compression: Asl,com = 1137.257
       -Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL,ten = 16.80

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR =   *Vn = 475023.398
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 558851.057
  VCol = 558851.057
  knl = 1.00

displacement_ductility_demand = 0.00

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 = 22.75, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
  Mu = 1.3974459E-010
  Vu = 1.1783778E-013
d = 0.8*h = 320.00
Nu = 5974.527
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 251327.412
where:
Vs1 = 251327.412 is calculated for jacket, with:
  d = 320.00
  Av = 157079.633
  fy = 500.00
  s = 100.00
Vs1 is multiplied by Col1 = 1.00
  s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
  d = 160.00
  Av = 100530.965
  fy = 400.00
  s = 250.00
Vs2 is multiplied by Col2 = 0.00
  s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
  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 = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
  Ef = 64828.00
   fe = 0.004, from (11.6a), ACI 440
     with fu = 0.01
From (11-11), ACI 440: Vs + Vf <= 405571.497
  bw = 400.00

----

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 = 1.3486692E-022
y = (My*Ls/3)/EIeff = 0.00355215 ((4.29),Biskinis Phd))
My = 1.2106E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7040E+013
  factor = 0.30
    Ag = 160000.00
    Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 29.75
    N = 5974.527
  Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.6801E+013

Calculation of Yielding Moment My

Calculation of   y and My according to Annex 7   -

----

y = Min(y_ten, y_com)
y_ten = 5.7839606E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 296.8901
   d = 357.00
   y = 0.28109378
  A = 0.01888488
  B = 0.01064174
   with pt = 0.00796398
     pc = 0.00796398
     pv = 0.00281599
     N = 5974.527
     b = 400.00
     " = 0.12044818
y_comp = 2.3130541E-005
with fc* (12.3, (ACI 440)) = 34.65043
   fc = 33.00
   fl = 0.93147527
   b = 400.00
   h = 400.00
   Ag = 160000.00
   From (12.9), ACI 440: ka = 0.56518315
     g = pt + pc + pv = 0.01874396
    rc = 40.00
    Ae/Ac = 0.56518315
    Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
   effective strain from (12.5) and (12.12), efe = 0.004
    fu = 0.01
  Ef = 64828.00
  Ec = 26999.444
   y = 0.27975145
  A = 0.0186534
  B = 0.01050082
   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 JC1 of floor 1
At local axis: 3
Integration Section: (b)

Calculation No. 16

column C1, Floor 1

Limit State: Collapse Prevention (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 JC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcjrs

Constant Properties

Knowledge Factor, = 0.85
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 = 555.5556
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.4444
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556
##
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.13212
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups 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
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
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 = -1.8468314E-031
EDGE -B-
Shear Force, Vb = 1.8468314E-031
BOTH EDGES
Axial Force, F = -5976.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1137.257
     -Compression: Asl,com = 1137.257
        -Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.18171192
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 115036.425
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.7255E+008
   Mu1+ = 1.7255E+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- = 1.7255E+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-) = 1.7255E+008
   Mu2+ = 1.7255E+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- = 1.7255E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
   u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
   b = 400.00
   d = 357.00
   d' = 43.00
   v = 0.00126831
      N = 5976.808
   fc = 33.00
      co (5A.5, TBDY) = 0.002

Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
   The Shear_factor is considered equal to 1 (pure moment strength)
   From (5.4b), TBDY: cu = 0.01608084
     we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.09892348
   where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
   ----
   fx = 0.07683125
    af = 0.57333333
       b = 400.00
       h = 400.00
    From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
       bw = 400.00
    effective stress from (A.35), ff,e = 870.5244
   ----
   fy = 0.07683125
    af = 0.57333333
       b = 400.00
       h = 400.00
    From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
       bw = 400.00
    effective stress from (A.35), ff,e = 870.5244

   R = 40.00
   Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
   fu,f = 1055.00
   Ef = 64828.00
    u,f = 0.015
   ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
      ase1 = 0.24250288
         bo_1 = 340.00
         ho_1 = 340.00
          bi2_1 = 462400.00
      ase2 = Max(ase1,ase2) = 0.24250288
         bo_2 = 192.00
         ho_2 = 192.00
          bi2_2 = 147456.00
   psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
   ----
   psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
      ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
         Ash1 = Astir_1*ns_1 = 157.0796
            No stirups, ns_1 = 2.00
         h1 = 400.00
      ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
         Ash2 = Astir_2*ns_2 = 100.531
            No stirups, ns_2 = 2.00
         h2 = 200.00
   ----
   psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
      ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
         Ash1 = Astir_1*ns_1 = 157.0796
            No stirups, ns_1 = 2.00
         h1 = 400.00
      ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
         Ash2 = Astir_2*ns_2 = 100.531
            No stirups, ns_2 = 2.00
         h2 = 200.00

      Asec = 160000.00
      s1 = 100.00
      s2 = 250.00
    fywe1 = 694.4444
    fywe2 = 555.5556
    fce = 33.00
   From ((5.A5), TBDY), TBDY: cc = 0.00332119
      c = confinement factor = 1.13212
  y1 = 0.00140044

sh1 = 0.0044814
ft1 = 441.538
fy1 = 367.9484
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 = 367.9484
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 441.538
fy2 = 367.9484
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 = 367.9484
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.813
fyv = 389.0108
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 = 389.0108
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
cc (5A.5, TBDY) = 0.00332119
    c = confinement factor = 1.13212
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.19835408

Mu = MRc (4.14) = 1.7255E+008
  u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
    N = 5976.808
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
      The Shear_factor is considered equal to 1 (pure moment strength)
      From (5.4b), TBDY: cu = 0.01608084
        we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.09892348
      where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
      ----
        fx = 0.07683125
        af = 0.57333333
          b = 400.00
          h = 400.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
          bw = 400.00
        effective stress from (A.35), ff,e = 870.5244
      ----
        fy = 0.07683125
        af = 0.57333333
          b = 400.00
          h = 400.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
          bw = 400.00
        effective stress from (A.35), ff,e = 870.5244

        R = 40.00
        Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
        fu,f = 1055.00
        Ef = 64828.00
         u,f = 0.015
        ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
          ase1 = 0.24250288
            bo_1 = 340.00
            ho_1 = 340.00
              bi2_1 = 462400.00
          ase2 = Max(ase1,ase2) = 0.24250288
            bo_2 = 192.00
            ho_2 = 192.00
              bi2_2 = 147456.00
        psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
      ----
        psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
          ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
            Ash1 = Astir_1*ns_1 = 157.0796

233

```
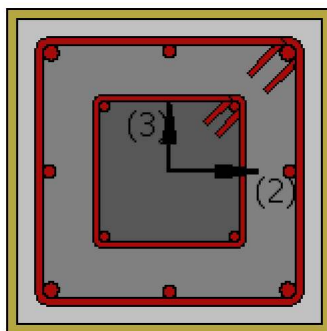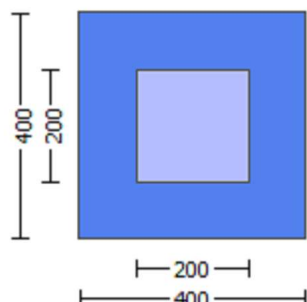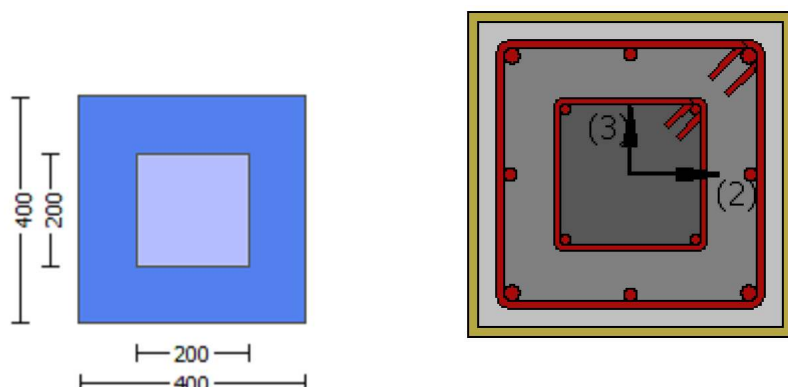                    No stirups, ns_1 = 2.00
              h1 = 400.00
           ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
              Ash2 = Astir_2*ns_2 = 100.531
                  No stirups, ns_2 = 2.00
              h2 = 200.00
      -----------------------------------------------------------------
         psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
           ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
              Ash1 = Astir_1*ns_1 = 157.0796
                  No stirups, ns_1 = 2.00
              h1 = 400.00
           ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
              Ash2 = Astir_2*ns_2 = 100.531
                  No stirups, ns_2 = 2.00
              h2 = 200.00
      -----------------------------------------------------------------
         Asec = 160000.00
         s1 = 100.00
         s2 = 250.00
       fywe1 = 694.4444
       fywe2 = 555.5556
       fce  = 33.00
    From ((5.A5), TBDY), TBDY:  cc = 0.00332119
         c  = confinement factor = 1.13212
  y1 = 0.00140044
  sh1 = 0.0044814
 ft1 = 441.538
 fy1 = 367.9484
  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 = 367.9484
     with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.00140044
  sh2 = 0.0044814
 ft2 = 441.538
 fy2 = 367.9484
  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 = 367.9484
     with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00140044
  shv = 0.0044814
 ftv = 466.813
 fyv = 389.0108
  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 = 389.0108
 with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
 2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
 v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
  b = 340.00
  d = 327.00
  d' = 13.00
  fcc (5A.2, TBDY) = 37.35991
   cc (5A.5, TBDY) = 0.00332119
     c = confinement factor = 1.13212
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
   2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
   v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
 u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
 u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
    N = 5976.808
  fc = 33.00
  co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.01608084
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx,   fy) = 0.09892348
    where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----
      fx = 0.07683125
      af = 0.57333333
        b = 400.00
        h = 400.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
        bw = 400.00
      effective stress from (A.35), ff,e = 870.5244
    ----
      fy = 0.07683125

af = 0.57333333
   b = 400.00
   h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
   bw = 400.00
effective stress from (A.35), ff,e = 870.5244

R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
  u,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
  ase1 = 0.24250288
    bo_1 = 340.00
    ho_1 = 340.00
     bi2_1 = 462400.00
  ase2 = Max(ase1,ase2) = 0.24250288
    bo_2 = 192.00
    ho_2 = 192.00
     bi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633

----

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
  ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
    Ash1 = Astir_1*ns_1 = 157.0796
     No stirups, ns_1 = 2.00
    h1 = 400.00
  ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
    Ash2 = Astir_2*ns_2 = 100.531
     No stirups, ns_2 = 2.00
    h2 = 200.00

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
  ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
    Ash1 = Astir_1*ns_1 = 157.0796
     No stirups, ns_1 = 2.00
    h1 = 400.00
  ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
    Ash2 = Astir_2*ns_2 = 100.531
     No stirups, ns_2 = 2.00
    h2 = 200.00

Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.4444
fywe2 = 555.5556
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00332119
  c = confinement factor = 1.13212
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 441.538
fy1 = 367.9484
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 = 367.9484
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.00140044
sh2 = 0.0044814
ft2 = 441.538
fy2 = 367.9484
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 = 367.9484
     with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.813
fyv = 389.0108
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 = 389.0108
     with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
    2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
    v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
  b = 340.00
  d = 327.00
  d' = 13.00
  fcc (5A.2, TBDY) = 37.35991
    cc (5A.5, TBDY) = 0.00332119
      c = confinement factor = 1.13212
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
    2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
    v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
  u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

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

```
  u = 1.7890363E-005
Mu = 1.7255E+008
-----------------------------------------------------------------------------
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
    N = 5976.808
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of  cu:  cu* = shear_factor * Max( cu, cc) = 0.01608084
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY:  cu = 0.01608084
       we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min( fx,  fy) = 0.09892348
     where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
     -------------------------------------------------------------------
       fx = 0.07683125
       af = 0.57333333
         b = 400.00
         h = 400.00
       From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
         bw = 400.00
       effective stress from (A.35), ff,e = 870.5244
     -------------------------------------------------------------------
       fy = 0.07683125
       af = 0.57333333
         b = 400.00
         h = 400.00
       From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
         bw = 400.00
       effective stress from (A.35), ff,e = 870.5244
     -------------------------------------------------------------------
       R = 40.00
       Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
       fu,f = 1055.00
       Ef = 64828.00
        u,f = 0.015
       ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
          ase1 = 0.24250288
             bo_1 = 340.00
             ho_1 = 340.00
              bi2_1 = 462400.00
       ase2 = Max(ase1,ase2) = 0.24250288
             bo_2 = 192.00
             ho_2 = 192.00
              bi2_2 = 147456.00
       psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
     -------------------------------------------------------------------
       psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
          ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
             Ash1 = Astir_1*ns_1 = 157.0796
                No stirups, ns_1 = 2.00
             h1 = 400.00
          ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
             Ash2 = Astir_2*ns_2 = 100.531
                No stirups, ns_2 = 2.00
             h2 = 200.00
     -------------------------------------------------------------------
       psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
          ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
             Ash1 = Astir_1*ns_1 = 157.0796
                No stirups, ns_1 = 2.00
             h1 = 400.00
          ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
             Ash2 = Astir_2*ns_2 = 100.531
                No stirups, ns_2 = 2.00
```

```
          h2 = 200.00
     --------------------------------------------------------------
          Asec = 160000.00
            s1 = 100.00
            s2 = 250.00
         fywe1 = 694.4444
         fywe2 = 555.5556
          fce = 33.00
     From ((5.A5), TBDY):  cc = 0.00332119
          c = confinement factor = 1.13212
    y1 = 0.00140044
   sh1 = 0.0044814
  ft1 = 441.538
  fy1 = 367.9484
   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 = 367.9484
       with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
    y2 = 0.00140044
   sh2 = 0.0044814
  ft2 = 441.538
  fy2 = 367.9484
   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 = 367.9484
       with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
    yv = 0.00140044
   shv = 0.0044814
  ftv = 466.813
  fyv = 389.0108
   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 = 389.0108
       with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
     2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
     v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
 and confined core properties:
   b = 340.00
   d = 327.00
   d' = 13.00
   fcc (5A.2, TBDY) = 37.35991
```

cc (5A.5, TBDY) = 0.00332119
         c = confinement factor = 1.13212
       1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
       2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
       v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
  u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 633070.334

Calculation of Shear Strength at edge 1, Vr1 = 633070.334
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 633070.334
  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 = 29.75, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
     Mu = 8.4878329E-012
     Vu = 1.8468314E-031
  d = 0.8*h = 320.00
  Nu = 5976.808
  Ag = 160000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279252.68
  where:
  Vs1 = 279252.68 is calculated for jacket, with:
    d = 320.00
    Av = 157079.633
    fy = 555.5556
    s = 100.00
  Vs1 is multiplied by   Col1 = 1.00
    s/d = 0.3125
  Vs2 = 0.00 is calculated for core, with:
    d = 160.00
    Av = 100530.965
    fy = 444.4444
    s = 250.00
  Vs2 is multiplied by   Col2 = 0.00
    s/d = 1.5625
  Vf ((11-3)-(11.4), ACI 440) = 188111.148
    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 = 1.016

dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
   Ef = 64828.00
    fe = 0.004, from (11.6a), ACI 440
      with   fu = 0.01
  From (11-11), ACI 440: Vs + Vf < = 463788.751
    bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 633070.334
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 633070.334
  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 = 29.75, but fc^0.5 < = 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
    Mu = 8.4878329E-012
    Vu = 1.8468314E-031
  d = 0.8*h = 320.00
  Nu = 5976.808
  Ag = 160000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279252.68
  where:
  Vs1 = 279252.68 is calculated for jacket, with:
    d = 320.00
    Av = 157079.633
    fy = 555.5556
    s = 100.00
  Vs1 is multiplied by   Col1 = 1.00
    s/d = 0.3125
  Vs2 = 0.00 is calculated for core, with:
    d = 160.00
    Av = 100530.965
    fy = 444.4444
    s = 250.00
  Vs2 is multiplied by   Col2 = 0.00
    s/d = 1.5625
  Vf ((11-3)-(11.4), ACI 440) = 188111.148
    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 = 1.016
  dfv = d (figure 11.2, ACI 440) = 357.00
  ffe ((11-5), ACI 440) = 259.312
    Ef = 64828.00
     fe = 0.004, from (11.6a), ACI 440
       with   fu = 0.01
  From (11-11), ACI 440: Vs + Vf < = 463788.751
    bw = 400.00

End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjrs

Constant Properties

Knowledge Factor,   = 0.85
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 = 555.5556
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.4444
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 555.5556
##
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.13212
Element Length, L = 3000.00
Primary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups 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
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
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 = 3.2548216E-032
EDGE -B-
Shear Force, Vb = -3.2548216E-032
BOTH EDGES
Axial Force, F = -5976.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
    -Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)

```
        -Tension: Asl,ten = 1137.257
     -Compression: Asl,com = 1137.257
        -Middle: Asl,mid = 402.1239
------------------------------------------------------------
------------------------------------------------------------


Calculation of Shear Capacity ratio , Ve/Vr  =  0.18171192
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 115036.425
with
Mpr1 =  Max(Mu1+ , Mu1-) = 1.7255E+008
   Mu1+ = 1.7255E+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- = 1.7255E+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-) = 1.7255E+008
   Mu2+ = 1.7255E+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- = 1.7255E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination
```

Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
     N = 5976.808
  fc = 33.00
   εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.01608084
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: εcu = 0.01608084
       ωwe ((5.4c), TBDY) = αse*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.09892348
     where ωf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

        ωfx = 0.07683125
        αf = 0.57333333
           b = 400.00
           h = 400.00
        From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00508
           bw = 400.00
        effective stress from (A.35), ff,e = 870.5244

        ωfy = 0.07683125
        αf = 0.57333333
           b = 400.00
           h = 400.00
        From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00508
           bw = 400.00
        effective stress from (A.35), ff,e = 870.5244

        R = 40.00
        Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
        fu,f = 1055.00
        Ef = 64828.00
         εu,f = 0.015
        αse ((5.4d), TBDY) = (αse1*Aext+αse2*Aint)/Asec = 0.24250288

```
              ase1 = 0.24250288
                 bo_1 = 340.00
                 ho_1 = 340.00
                  bi2_1 = 462400.00
           ase2 = Max(ase1,ase2) = 0.24250288
                 bo_2 = 192.00
                 ho_2 = 192.00
                  bi2_2 = 147456.00
           psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
         -----------------------------------------------------------------
           psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
              ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
                 Ash1 = Astir_1*ns_1 = 157.0796
                    No stirups, ns_1 = 2.00
                 h1 = 400.00
              ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
                 Ash2 = Astir_2*ns_2 = 100.531
                    No stirups, ns_2 = 2.00
                 h2 = 200.00
         -----------------------------------------------------------------
           psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
              ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
                 Ash1 = Astir_1*ns_1 = 157.0796
                    No stirups, ns_1 = 2.00
                 h1 = 400.00
              ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
                 Ash2 = Astir_2*ns_2 = 100.531
                    No stirups, ns_2 = 2.00
                 h2 = 200.00
         -----------------------------------------------------------------
              Asec = 160000.00
              s1 = 100.00
              s2 = 250.00
           fywe1 = 694.4444
           fywe2 = 555.5556
           fce = 33.00
        From ((5.A5), TBDY), TBDY:  cc = 0.00332119
             c  = confinement factor = 1.13212
     y1 = 0.00140044
    sh1 = 0.0044814
   ft1 = 441.538
   fy1 = 367.9484
    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 = 367.9484
       with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
     y2 = 0.00140044
    sh2 = 0.0044814
   ft2 = 441.538
   fy2 = 367.9484
    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 = 367.9484
  with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.813
fyv = 389.0108
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 = 389.0108
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
  b = 340.00
  d = 327.00
  d' = 13.00
  fcc (5A.2, TBDY) = 37.35991
  cc (5A.5, TBDY) = 0.00332119
   c = confinement factor = 1.13212
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
  2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
  v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
 u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
 u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
   N = 5976.808
  fc = 33.00
  co (5A.5, TBDY) = 0.002
  Final value of   cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
   The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: cu = 0.01608084
    we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.09892348
  where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----
   fx = 0.07683125
    af = 0.57333333
       b = 400.00
       h = 400.00
   From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
       bw = 400.00
   effective stress from (A.35), ff,e = 870.5244
----
   fy = 0.07683125
    af = 0.57333333
       b = 400.00
       h = 400.00
   From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
       bw = 400.00
   effective stress from (A.35), ff,e = 870.5244

   R = 40.00
   Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
   fu,f = 1055.00
   Ef = 64828.00
    u,f = 0.015
   ase ((5.4d), TBDY) = (ase1*Aext+ ase2*Aint)/Asec = 0.24250288
      ase1 = 0.24250288
          bo_1 = 340.00
          ho_1 = 340.00
           bi2_1 = 462400.00
      ase2 = Max(ase1,ase2) = 0.24250288
          bo_2 = 192.00
          ho_2 = 192.00
           bi2_2 = 147456.00
   psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
----
   psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
      ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
         Ash1 = Astir_1*ns_1 = 157.0796
            No stirups, ns_1 = 2.00
         h1 = 400.00
      ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
         Ash2 = Astir_2*ns_2 = 100.531
            No stirups, ns_2 = 2.00
         h2 = 200.00
----
   psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
      ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
         Ash1 = Astir_1*ns_1 = 157.0796
            No stirups, ns_1 = 2.00
         h1 = 400.00
      ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
         Ash2 = Astir_2*ns_2 = 100.531
            No stirups, ns_2 = 2.00
         h2 = 200.00

       Asec = 160000.00
       s1 = 100.00
       s2 = 250.00
     fywe1 = 694.4444
     fywe2 = 555.5556
     fce = 33.00
   From ((5.A5), TBDY), TBDY: cc = 0.00332119
       c = confinement factor = 1.13212
  y1 = 0.00140044
  sh1 = 0.0044814
ft1 = 441.538

fy1 = 367.9484
  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 = 367.9484
     with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.00140044
  sh2 = 0.0044814
ft2 = 441.538
fy2 = 367.9484
  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 = 367.9484
     with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00140044
  shv = 0.0044814
ftv = 466.813
fyv = 389.0108
  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 = 389.0108
     with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
  2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
  v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
  b = 340.00
  d = 327.00
  d' = 13.00
  fcc (5A.2, TBDY) = 37.35991
  cc (5A.5, TBDY) = 0.00332119
    c = confinement factor = 1.13212
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
    2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
    v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
 u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  ν = 0.00126831
    N = 5976.808
  fc = 33.00
   εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.01608084
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: εcu = 0.01608084
       ωwe ((5.4c), TBDY) = αse*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.09892348
     where ωf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

       ωfx = 0.07683125
       αf = 0.57333333
          b = 400.00
          h = 400.00
        From EC8 A4.4.3(6), ρf = 2tf/bw = 0.00508
          bw = 400.00
        effective stress from (A.35), ff,e = 870.5244

       ωfy = 0.07683125
       αf = 0.57333333
          b = 400.00
          h = 400.00
        From EC8 A4.4.3(6), ρf = 2tf/bw = 0.00508
          bw = 400.00
        effective stress from (A.35), ff,e = 870.5244

       R = 40.00
       Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
       fu,f = 1055.00
       Ef = 64828.00
        εu,f = 0.015
       αse ((5.4d), TBDY) = (αse1*Aext+αse2*Aint)/Asec = 0.24250288
          αse1 = 0.24250288
             bo_1 = 340.00
             ho_1 = 340.00
               bi2_1 = 462400.00
          αse2 = Max(αse1,αse2) = 0.24250288
             bo_2 = 192.00
             ho_2 = 192.00
               bi2_2 = 147456.00
       ρsh,min*Fywe = Min(ρsh,x*Fywe , ρsh,y*Fywe) = 3.00633

       ρsh_x*Fywe = ρsh1*Fywe1+ρs2*Fywe2 = 3.00633
          ρs1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
             Ash1 = Astir_1*ns_1 = 157.0796
                No stirups, ns_1 = 2.00
             h1 = 400.00

```
        ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
            Ash2 = Astir_2*ns_2 = 100.531
                No stirups, ns_2 = 2.00
            h2 = 200.00
        ----------------------------------------------------------------
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
            ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
                Ash1 = Astir_1*ns_1 = 157.0796
                    No stirups, ns_1 = 2.00
                h1 = 400.00
            ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
                Ash2 = Astir_2*ns_2 = 100.531
                    No stirups, ns_2 = 2.00
                h2 = 200.00
        ----------------------------------------------------------------
        Asec = 160000.00
        s1 = 100.00
        s2 = 250.00
      fywe1 = 694.4444
      fywe2 = 555.5556
      fce  = 33.00
    From ((5.A5), TBDY), TBDY:  cc = 0.00332119
        c  = confinement factor = 1.13212
```
$y1 = 0.00140044$
$sh1 = 0.0044814$
$ft1 = 441.538$
$fy1 = 367.9484$
$su1 = 0.00512$
    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 = 367.9484
      with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
$y2 = 0.00140044$
$sh2 = 0.0044814$
$ft2 = 441.538$
$fy2 = 367.9484$
$su2 = 0.00512$
    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 = 367.9484
      with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
$yv = 0.00140044$
$shv = 0.0044814$
$ftv = 466.813$
$fyv = 389.0108$
$suv = 0.00512$
    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 = 389.0108
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
 2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
 v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
  b = 340.00
  d = 327.00
  d' = 13.00
  fcc (5A.2, TBDY) = 37.35991
   cc (5A.5, TBDY) = 0.00332119
     c = confinement factor = 1.13212
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
     2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
     v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
  u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 1.7890363E-005
Mu = 1.7255E+008
----
with full section properties:
  b = 400.00
  d = 357.00
  d' = 43.00
  v = 0.00126831
    N = 5976.808
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of   cu: cu* = shear_factor * Max(cu, cc) = 0.01608084
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.01608084
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx,   fy) = 0.09892348
    where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
      ----
      fx = 0.07683125
       af = 0.57333333
          b = 400.00
          h = 400.00
       From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00508
          bw = 400.00
       effective stress from (A.35), ff,e = 870.5244
      ----
      fy = 0.07683125
       af = 0.57333333
          b = 400.00

```
        h = 400.00
     From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
        bw = 400.00
     effective stress from (A.35), ff,e = 870.5244
    ------------------------------------------------------------
     R = 40.00
     Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
     fu,f = 1055.00
     Ef = 64828.00
      u,f = 0.015
     ase ((5.4d), TBDY) = (ase1*Aext+ ase2*Aint)/Asec = 0.24250288
        ase1 = 0.24250288
           bo_1 = 340.00
           ho_1 = 340.00
            bi2_1 = 462400.00
        ase2 = Max(ase1,ase2) = 0.24250288
           bo_2 = 192.00
           ho_2 = 192.00
            bi2_2 = 147456.00
     psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.00633
    ------------------------------------------------------------
     psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
        ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
           Ash1 = Astir_1*ns_1 = 157.0796
              No stirups, ns_1 = 2.00
           h1 = 400.00
        ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
           Ash2 = Astir_2*ns_2 = 100.531
              No stirups, ns_2 = 2.00
           h2 = 200.00
    ------------------------------------------------------------
     psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.00633
        ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
           Ash1 = Astir_1*ns_1 = 157.0796
              No stirups, ns_1 = 2.00
           h1 = 400.00
        ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
           Ash2 = Astir_2*ns_2 = 100.531
              No stirups, ns_2 = 2.00
           h2 = 200.00
    ------------------------------------------------------------
        Asec = 160000.00
        s1 = 100.00
        s2 = 250.00
     fywe1 = 694.4444
     fywe2 = 555.5556
     fce  = 33.00
   From ((5.A5), TBDY), TBDY:  cc = 0.00332119
        c = confinement factor = 1.13212
  y1 = 0.00140044
  sh1 = 0.0044814
 ft1 = 441.538
 fy1 = 367.9484
  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 = 367.9484
     with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.00140044
  sh2 = 0.0044814
```

ft2 = 441.538
fy2 = 367.9484
 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 = 367.9484
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00140044
  shv = 0.0044814
 ftv = 466.813
 fyv = 389.0108
  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 = 389.0108
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.088798
   2 = Asl,com/(b*d)*(fs2/fc) = 0.088798
   v = Asl,mid/(b*d)*(fsv/fc) = 0.03319551
and confined core properties:
  b = 340.00
  d = 327.00
  d' = 13.00
 fcc (5A.2, TBDY) = 37.35991
   cc (5A.5, TBDY) = 0.00332119
     c = confinement factor = 1.13212
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.11405247
   2 = Asl,com/(b*d)*(fs2/fc) = 0.11405247
   v = Asl,mid/(b*d)*(fsv/fc) = 0.04263644
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.19835408
Mu = MRc (4.14) = 1.7255E+008
  u =   su (4.1) = 1.7890363E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 633070.334

Calculation of Shear Strength at edge 1, Vr1 = 633070.334
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 633070.334
  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 = 29.75, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
    Mu = 1.4989884E-012
    Vu = 3.2548216E-032
  d = 0.8*h = 320.00
  Nu = 5976.808
  Ag = 160000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279252.68
  where:
  Vs1 = 279252.68 is calculated for jacket, with:
    d = 320.00
    Av = 157079.633
    fy = 555.5556
    s = 100.00
  Vs1 is multiplied by   Col1 = 1.00
    s/d = 0.3125
  Vs2 = 0.00 is calculated for core, with:
    d = 160.00
    Av = 100530.965
    fy = 444.4444
    s = 250.00
  Vs2 is multiplied by   Col2 = 0.00
    s/d = 1.5625
  Vf ((11-3)-(11.4), ACI 440) = 188111.148
    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 = 1.016
  dfv = d (figure 11.2, ACI 440) = 357.00
  ffe ((11-5), ACI 440) = 259.312
    Ef = 64828.00
     fe = 0.004, from (11.6a), ACI 440
       with  fu = 0.01
  From (11-11), ACI 440: Vs + Vf <= 463788.751
    bw = 400.00
------------------------------------------------------------
------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 633070.334
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 633070.334
  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 = 29.75, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
    Mu = 1.4989884E-012
    Vu = 3.2548216E-032
  d = 0.8*h = 320.00
  Nu = 5976.808
  Ag = 160000.00
  From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279252.68
  where:
```

Vs1 = 279252.68 is calculated for jacket, with:
   d = 320.00
   Av = 157079.633
   fy = 555.5556
   s = 100.00
  Vs1 is multiplied by Col1 = 1.00
   s/d = 0.3125
  Vs2 = 0.00 is calculated for core, with:
   d = 160.00
   Av = 100530.965
   fy = 444.4444
   s = 250.00
  Vs2 is multiplied by Col2 = 0.00
   s/d = 1.5625
  Vf ((11-3)-(11.4), ACI 440) = 188111.148
   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 = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
   Ef = 64828.00
    fe = 0.004, from (11.6a), ACI 440
     with fu = 0.01
 From (11-11), ACI 440: Vs + Vf <= 463788.751
   bw = 400.00

End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rcjrs

Constant Properties

Knowledge Factor, = 0.85
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 = 555.5556
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Primary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Primary Member: Steel Strength, fs = fsm = 444.4444
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Primary Member

Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups 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
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
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 = 0.05279463
Shear Force, V2 = 5699.261
Shear Force, V3 = -1.1783778E-013
Axial Force, F = -5974.527
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
      -Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1137.257
      -Compression: Asl,com = 1137.257
        -Middle: Asl,mid = 402.1239
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,jacket = 829.3805
      -Compression: Asl,com,jacket = 829.3805
        -Middle: Asl,mid,jacket = 402.1239
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,core = 307.8761
      -Compression: Asl,com,core = 307.8761
        -Middle: Asl,mid,core = 0.00
Mean Diameter of Tension Reinforcement, DbL = 16.80

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity u,R = * u = 0.03630387
 u = y + p = 0.04271043

 - Calculation of y -
----
 y = (My*Ls/3)/Eleff = 0.00071043 ((4.29),Biskinis Phd))
 My = 1.2106E+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 = 1.7040E+013
    factor = 0.30
       Ag = 160000.00
       Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 29.75
       N = 5974.527
    Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.6801E+013

Calculation of Yielding Moment My

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

y_ten = 5.7839606E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 296.8901
    d = 357.00
     y = 0.28109378
    A = 0.01888488
    B = 0.01064174
     with pt = 0.00680079
         pc = 0.00796398
         pv = 0.00281599
         N = 5974.527
         b = 400.00
          " = 0.12044818
 y_comp = 2.3130541E-005
with fc* (12.3, (ACI 440)) = 34.65043
    fc = 33.00
    fl = 0.93147527
    b = 400.00
    h = 400.00
    Ag = 160000.00
    From (12.9), ACI 440: ka = 0.56518315
       g = pt + pc + pv = 0.01874396
      rc = 40.00
      Ae/Ac = 0.56518315
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
    effective strain from (12.5) and (12.12), efe = 0.004
     fu = 0.01
    Ef = 64828.00
    Ec = 26999.444
     y = 0.27975145
    A = 0.0186534
    B = 0.01050082
     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 = 0.042
with:
- Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
  shear control ratio VyE/VColOE = 0.18171192
  d = d_external = 357.00
  s = s_external = 0.00
   t =   s1 +   s2 + 2*tf/bw*(ffe/fs) = 0.00680079
  jacket: s1 = Av1*h1/(s1*Ag) = 0.00392699
       Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
       h1 = 400.00
       s1 = 100.00
  core: s2 = Av2*h2/(s2*Ag) = 0.00050265
       Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
       h2 = 200.00
       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 = 5974.527
   Ag = 160000.00
   f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 29.75
   fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein =
529.9948
   fytE = (fy_ext_Trans_Reinf*Area_ext_Trans_Reinf+fy_int_Trans_Reinf*Area_int_Trans_Reinf)/Area_Tot_Trans_Rein =

542.9472
pl = Area_Tot_Long_Rein/(b*d) = 0.01874396
   b = 400.00
   d = 357.00
     f'cE = 29.75

End Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 3
Integration Section: (b)