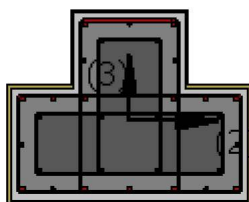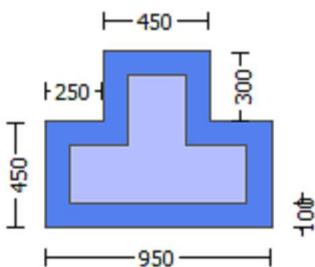# Detailed Member Calculations

Units: N&mm

Regulation: ASCE 41-17

Calculation No. 1

column C1, Floor 1

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

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (2)

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

Constant Properties

Knowledge Factor, = 0.90
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of y for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.44
##
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = lb = 300.00
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 = -2.4941E+007
Shear Force, Va = -8272.465
EDGE -B-
Bending Moment, Mb = 118914.623
Shear Force, Vb = 8272.465
BOTH EDGES
Axial Force, F = -21341.949
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1539.38
     -Compression: Asl,com = 1539.38
         -Middle: Asl,mid = 3612.832
Mean Diameter of Tension Reinforcement, DbL,ten = 16.57143

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = \kappa * V_n = 1.1114E+006$

V_n ((10.3), ASCE 41-17) = $k_{nl}*V_{Col0}$ = 1.2349E+006

  V_{Col} = 1.2349E+006

 k_{nl} = 1.00

   displacement_ductility_demand = 0.02066895

NOTE: In expression (10-3) '$V_s = A_v*f_y*d/s$' is replaced by '$V_s + \psi_f*V_f$'

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

   λ = 1 (normal-weight concrete)

  Mean concrete strength: f_c' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 20.80, but $f_c^{0.5}$ <= 8.3 MPa (22.5.3.1, ACI 318-14)

  M/Vd = 3.96705

   M_u = 2.4941E+007

   V_u = 8272.465

  $d = 0.8*h$ = 760.00

  N_u = 21341.949

  A_g = 427500.00

  From (11.5.4.8), ACI 318-14: V_s = Vs,jacket + Vs,core = 976155.669

  where:

 Vs,jacket = Vs,j1 + Vs,j2 = 879645.943

  Vs,j1 = 282743.339 is calculated for section web jacket, with:

   d = 360.00

   A_v = 157079.633

   f_y = 500.00

   s = 100.00

  Vs,j1 is multiplied by $\lambda_{Col,j1}$ = 1.00

   s/d = 0.27777778

  Vs,j2 = 596902.604 is calculated for section flange jacket, with:

   d = 760.00

   A_v = 157079.633

   f_y = 500.00

   s = 100.00

  Vs,j2 is multiplied by $\lambda_{Col,j2}$ = 1.00

   s/d = 0.13157895

 Vs,core = Vs,c1 + Vs,c2 = 96509.726

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

   d = 200.00

   A_v = 100530.965

   f_y = 400.00

   s = 250.00

  Vs,c1 is multiplied by $\lambda_{Col,c1}$ = 0.00

   s/d = 1.25

  Vs,c2 = 96509.726 is calculated for section flange core, with:

   d = 600.00

   A_v = 100530.965

   f_y = 400.00

   s = 250.00

  Vs,c2 is multiplied by $\lambda_{Col,c2}$ = 1.00

   s/d = 0.41666667

 V_f ((11-3)-(11.4), ACI 440) = 477918.239

  ψ_f = 0.95, for fully-wrapped sections

 wf/sf = 1 (FRP strips adjacent to one another).

 In (11.3) $\sin\beta + \cos\beta$ is replaced with $(\cot\theta + \cot\alpha)\sin\alpha$ which is more a generalised expression,

 where θ is the angle of the crack direction (see KANEPE).

 This later relation, considered as a function $V_f(\theta, \alpha)$, is implemented for every different fiber orientation a_i,

 as well as for 2 crack directions, θ =45° and θ =-45° to take into consideration the cyclic seismic loading.

 orientation 1: $\alpha_1 = b_1 + 90°$ = 90.00

 V_f = Min(|Vf(45, α_1)|,|Vf(-45,a1)|), with:

 total thickness per orientation, t_{f1} = NL*t/NoDir = 1.016

 d_{fv} = d (figure 11.2, ACI 440) = 907.00

 f_{fe} ((11-5), ACI 440) = 259.312

   E_f = 64828.00

   ϵ_{fe} = 0.004, from (11.6a), ACI 440

    with ϵ_{fu} = 0.01

 From (11-11), ACI 440: Vs + Vf <= 1.0362E+006

  b_w = 450.00

----
displacement_ductility_demand is calculated as   / y

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

From analysis, chord rotation   = 6.0321203E-005
 y = (My*Ls/3)/EIeff = 0.00291845 ((4.29),Biskinis Phd))
  My = 7.6202E+008
  Ls = M/V (with Ls > 0.1*L and Ls < 2*L) = 3014.959
  From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 2.6241E+014
    factor = 0.30
      Ag = 562500.00
      Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333
      N = 21341.949
    Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 8.7468E+014

Calculation of Yielding Moment My

Calculation of   y and My according to Annex 7 -
----
 y = Min(y_ten, y_com)
 y_ten = 2.6145845E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 352.1657
   d = 907.00
    y = 0.25748191
   A = 0.01654341
   B = 0.00873458
    with pt = 0.0037716
       pc = 0.0037716
       pv = 0.00885172
       N = 21341.949
       b = 450.00
        " = 0.04740904
 y_comp = 9.5509837E-006
 with fc* (12.3, (ACI 440)) = 33.253
    fc = 33.00
    fl = 0.43533893
    b = bmax = 950.00
    h = hmax = 750.00
    Ag = 0.5625
       g = pt + pc + pv = 0.01639493
    rc = 40.00
    Ae/Ac = 0.29742395
    Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
   effective strain from (12.5) and (12.12), efe = 0.004
    fu = 0.01
   Ef = 64828.00
   Ec = 26999.444
    y = 0.25591344
   A = 0.016277
   B = 0.0085861
    with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.38756552
lb = 300.00
ld = 774.0627
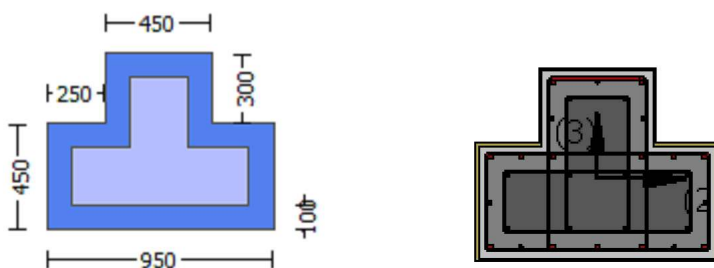Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
    = 1

db = 16.66667
Mean strength value of all re-bars: fy = 524.4464
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  t = 1.00
  s = 0.80
  e = 1.00
cb = 25.00
Ktr = 1.37392
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 30.00

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

Calculation No. 2

column C1, Floor 1

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

Analysis: Uniform +X

Check: Chord rotation capacity (u)

Edge: Start

Local Axis: (2)

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

Constant Properties

Knowledge Factor, = 0.90
Mean strength values are used for both shear and moment calculations.
Consequently:

Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 555.55
##
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.02437
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
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 = -0.00053663
EDGE -B-
Shear Force, Vb = 0.00053663
BOTH EDGES
Axial Force, F = -20792.011
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1539.38
     -Compression: Asl,com = 2475.575
         -Middle: Asl,mid = 2676.637

Calculation of Shear Capacity ratio , Ve/Vr = 0.56344875

Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 624335.951
with
Mpr1 = Max(Mu1+ , Mu1-) = 9.3650E+008
  Mu1+ = 6.7320E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
  Mu1- = 9.3650E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 9.3650E+008
  Mu2+ = 6.7320E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
  Mu2- = 9.3650E+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 = 9.1136953E-006
Mu = 6.7320E+008
----
with full section properties:
  b = 950.00
  d = 707.00
  d' = 43.00
  v = 0.00093808
    N = 20792.011
  fc = 33.00
   εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu^* = shear_factor * Max(εcu, εcc) = 0.01209008
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.01209008
      ωwe ((5.4c), TBDY) = $\alpha se^* \rho sh,min^*fywe/fce+Min(\omega fx, \omega fy)$ = 0.04611842
    where $\omega f = \alpha f^* \rho f^* ffe/fce$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

      ωfx = 0.03444474
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

      ωfy = 0.03444474
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

      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
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
        ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)

"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
        is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
        is calculated by reducing all the dimensions of the area Aconf,max1 by a length
        equal to half the clear spacing between external hoops.
AnoConf1 = 173066.667 is the unconfined external core area which is equal to   bi2/6 as defined at (A.2).
ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
                is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
        Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
                is calculated by reducing all the dimensions of the area Aconf,max2 by a length
                equal to half the clear spacing between internal hoops.
        AnoConf2 = 110709.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
    psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
    ----
    psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
    psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
        Lstir1 (Length of stirrups along Y) = 2160.00
        Astir1 (stirrups area) = 78.53982
    psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
        Lstir2 (Length of stirrups along Y) = 1568.00
        Astir2 (stirrups area) = 50.26548
    ----
    psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
    psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
        Lstir1 (Length of stirrups along X) = 2560.00
        Astir1 (stirrups area) = 78.53982
    psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
        Lstir2 (Length of stirrups along X) = 1968.00
        Astir2 (stirrups area) = 50.26548

    Asec = 562500.00
    s1 = 100.00
    s2 = 250.00
    fywe1 = 694.45
    fywe2 = 555.55
    fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
    c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 458.0986
fy1 = 381.7488
su1 = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.31005242
    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 = 381.7488
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 453.4475

fy2 = 377.8729
  su2 = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
      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 = 377.8729
      with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00143155
  shv = 0.00458096
 ftv = 455.2307
 fyv = 379.359
  suv = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.31005242
      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 = 379.359
      with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.02651348
    2 = Asl,com/(b*d)*(fs2/fc) = 0.04220509
    v = Asl,mid/(b*d)*(fsv/fc) = 0.04581238
and confined core properties:
  b = 890.00
  d = 677.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.80412
   cc (5A.5, TBDY) = 0.00224367
      c = confinement factor = 1.02437
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.029555
    2 = Asl,com/(b*d)*(fs2/fc) = 0.0470467
    v = Asl,mid/(b*d)*(fsv/fc) = 0.0510678
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.14547789
Mu = MRc (4.14) = 6.7320E+008
 u =   su (4.1) = 9.1136953E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
    = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
    t = 1.00
    s = 0.80
    e = 1.00

```
   cb = 25.00
  Ktr = 1.37392
   Atr = Min(Atr_x,Atr_y) = 257.6106
   where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
   s = Max(s_external,s_internal) = 250.00
   n = 30.00
-------------------------------------------------------------------------
-------------------------------------------------------------------------
-------------------------------------------------------------------------
Calculation of Mu1-
-------------------------------------------------------------------------


-------------------------------------------------------------------------
Calculation of ultimate curvature  u according to 4.1, Biskinis/Fardis 2013:
  u = 9.8526632E-006
Mu = 9.3650E+008
-------------------------------------------------------------------------
with full section properties:
  b = 450.00
  d = 707.00
  d' = 43.00
  v = 0.00198039
    N = 20792.011
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of  cu:  cu* = shear_factor * Max( cu, cc) = 0.01209008
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY:  cu = 0.01209008
       we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min( fx,  fy) = 0.04611842
     where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
     ------------------------------------------------------------------
       fx = 0.03444474
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
        bmax = 950.00
        hmax = 750.00
        From EC8 A4.4.3(6), pf = 2tf/bw = 0.00451556
          bw = 450.00
        effective stress from (A.35), ff,e = 881.8461
     ------------------------------------------------------------------
       fy = 0.03444474
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
        bmax = 950.00
        hmax = 750.00
        From EC8 A4.4.3(6), pf = 2tf/bw = 0.00451556
          bw = 450.00
        effective stress from (A.35), ff,e = 881.8461
     ------------------------------------------------------------------
        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 = 0.53375773
          ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
          The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
          of the rectangular sections confinement, which is expressed by (5.4d).
          The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
          "Theoretical Stress-Strain Model for Confined Concrete."
          J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
          Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
                   is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
          Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
                   is calculated by reducing all the dimensions of the area Aconf,max1 by a length
```

equal to half the clear spacing between external hoops.

AnoConf1 = 173066.667 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).

ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773

The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.

Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.

Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.

AnoConf2 = 110709.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).

psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578

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

----

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
c = confinement factor = 1.02437

y1 = 0.00143155
sh1 = 0.00458096
ft1 = 453.4475
fy1 = 377.8729
su1 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 377.8729
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 458.0986
fy2 = 381.7488
su2 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242

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 = 381.7488
 with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00143155
shv = 0.00458096
ftv = 455.2307
fyv = 379.359
 suv = 0.00550601
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 lo/lou,min = lb/ld = 0.31005242
 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 = 379.359
 with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.08909964
2 = Asl,com/(b*d)*(fs2/fc) = 0.05597289
v = Asl,mid/(b*d)*(fsv/fc) = 0.09671502
and confined core properties:
b = 390.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 33.80412
cc (5A.5, TBDY) = 0.00224367
 c = confinement factor = 1.02437
1 = Asl,ten/(b*d)*(fs1/fc) = 0.10736299
2 = Asl,com/(b*d)*(fs2/fc) = 0.06744603
v = Asl,mid/(b*d)*(fsv/fc) = 0.11653935
Case/Assumption: Unconfinesd full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.20956863
Mu = MRc (4.14) = 9.3650E+008
u = su (4.1) = 9.8526632E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 = 1
db = 16.66667
Mean strength value of all re-bars: fy = 655.558
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
 t = 1.00
 s = 0.80
 e = 1.00
cb = 25.00
Ktr = 1.37392
 Atr = Min(Atr_x,Atr_y) = 257.6106
 where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
 s = Max(s_external,s_internal) = 250.00
 n = 30.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 9.1136953E-006
Mu = 6.7320E+008
----
with full section properties:
  b = 950.00
  d = 707.00
  d' = 43.00
  v = 0.00093808
    N = 20792.011
  fc = 33.00
  εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.01209008
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.01209008
      ωwe ((5.4c), TBDY) = αse*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.04611842
    where ωf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

    ωfx = 0.03444474
    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
    αf = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

    ωfy = 0.03444474
    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
    αf = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

    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 = 0.53375773
      αse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
      The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
      of the rectangular sections confinement, which is expressed by (5.4d).
      The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
      "Theoretical Stress-Strain Model for Confined Concrete."
      J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
      Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
              is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
      Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
              is calculated by reducing all the dimensions of the area Aconf,max1 by a length
              equal to half the clear spacing between external hoops.
      AnoConf1 = 173066.667 is the unconfined external core area which is equal to Σbi2/6 as defined at (A.2).
    αse2 (>=αse1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
      The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
      of the rectangular sections confinement, which is expressed by (5.4d).
      The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)

"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 110709.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 458.0986
fy1 = 381.7488
su1 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 381.7488
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 453.4475
fy2 = 377.8729
su2 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
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 = 377.8729

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
 yv = 0.00143155
 shv = 0.00458096
ftv = 455.2307
fyv = 379.359
 suv = 0.00550601
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.31005242
    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 = 379.359
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.02651348
 2 = Asl,com/(b*d)*(fs2/fc) = 0.04220509
 v = Asl,mid/(b*d)*(fsv/fc) = 0.04581238
and confined core properties:
  b = 890.00
  d = 677.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.80412
   cc (5A.5, TBDY) = 0.00224367
     c = confinement factor = 1.02437
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.029555
   2 = Asl,com/(b*d)*(fs2/fc) = 0.0470467
   v = Asl,mid/(b*d)*(fsv/fc) = 0.0510678
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.14547789
Mu = MRc (4.14) = 6.7320E+008
 u =   su (4.1) = 9.1136953E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
    = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
    t = 1.00
    s = 0.80
    e = 1.00
  cb = 25.00
  Ktr = 1.37392
   Atr = Min(Atr_x,Atr_y) = 257.6106
   where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
   s = Max(s_external,s_internal) = 250.00
   n = 30.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 9.8526632E-006
Mu = 9.3650E+008
----
with full section properties:
  b = 450.00
  d = 707.00
  d' = 43.00
  v = 0.00198039
    N = 20792.011
 fc = 33.00
  εco (5A.5, TBDY) = 0.002
 Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.01209008
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.01209008
      ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.04611842
    where ωf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

     ωfx = 0.03444474
    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
    αf = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A4.4.3(6), ρf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

     ωfy = 0.03444474
    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
    αf = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A4.4.3(6), ρf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
      fu,f = 1055.00
      Ef = 64828.00
       εu,f = 0.015
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
        ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
              is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
        Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
              is calculated by reducing all the dimensions of the area Aconf,max1 by a length
              equal to half the clear spacing between external hoops.
        AnoConf1 = 173066.667 is the unconfined external core area which is equal to Σbi2/6 as defined at (A.2).
      ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
              is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
        Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
              is calculated by reducing all the dimensions of the area Aconf,max2 by a length

equal to half the clear spacing between internal hoops.

     AnoConf2 = 110709.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).

    psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578

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

----

    psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578

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

      Lstir1 (Length of stirrups along Y) = 2160.00

      Astir1 (stirrups area) = 78.53982

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

      Lstir2 (Length of stirrups along Y) = 1568.00

      Astir2 (stirrups area) = 50.26548

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    psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307

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

      Lstir1 (Length of stirrups along X) = 2560.00

      Astir1 (stirrups area) = 78.53982

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

      Lstir2 (Length of stirrups along X) = 1968.00

      Astir2 (stirrups area) = 50.26548

     Asec = 562500.00

     s1 = 100.00

     s2 = 250.00

    fywe1 = 694.45

    fywe2 = 555.55

    fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00224367

    c = confinement factor = 1.02437

y1 = 0.00143155

sh1 = 0.00458096

ft1 = 453.4475

fy1 = 377.8729

su1 = 0.00550601

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

  and also multiplied by the shear_factor according to 15.7.1.4, with

  Shear_factor = 1.00

  lo/lou,min = lb/ld = 0.31005242

  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 = 377.8729

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

y2 = 0.00143155

sh2 = 0.00458096

ft2 = 458.0986

fy2 = 381.7488

su2 = 0.00550601

  using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242

  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 = 381.7488

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

yv = 0.00143155

shv = 0.00458096

ftv = 455.2307

fyv = 379.359

suv = 0.00550601

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
  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 = 379.359
   with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.08909964
  2 = Asl,com/(b*d)*(fs2/fc) = 0.05597289
  v = Asl,mid/(b*d)*(fsv/fc) = 0.09671502
and confined core properties:
 b = 390.00
 d = 677.00
 d' = 13.00
 fcc (5A.2, TBDY) = 33.80412
  cc (5A.5, TBDY) = 0.00224367
    c = confinement factor = 1.02437
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.10736299
   2 = Asl,com/(b*d)*(fs2/fc) = 0.06744603
   v = Asl,mid/(b*d)*(fsv/fc) = 0.11653935
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.20956863
Mu = MRc (4.14) = 9.3650E+008
  u =   su (4.1) = 9.8526632E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
    = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
    t = 1.00
    s = 0.80
    e = 1.00
  cb = 25.00
  Ktr = 1.37392
   Atr = Min(Atr_x,Atr_y) = 257.6106
   where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
   s = Max(s_external,s_internal) = 250.00
   n = 30.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.1081E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.1081E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 1.1081E+006
  knl = 1 (zero step-static loading)

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

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

    = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
    Mu = 761.1315
    Vu = 0.00053663
  d = 0.8*h = 600.00
  Nu = 20792.011
  Ag = 337500.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 916401.511
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 837764.743
  Vs,j1 = 523602.964 is calculated for section web jacket, with:
    d = 600.00
    Av = 157079.633
    fy = 555.56
    s = 100.00
  Vs,j1 is multiplied by   Col,j1 = 1.00
    s/d = 0.16666667
  Vs,j2 = 314161.779 is calculated for section flange jacket, with:
    d = 360.00
    Av = 157079.633
    fy = 555.56
    s = 100.00
  Vs,j2 is multiplied by   Col,j2 = 1.00
    s/d = 0.27777778
  Vs,core = Vs,c1 + Vs,c2 = 78636.768
  Vs,c1 = 78636.768 is calculated for section web core, with:
    d = 440.00
    Av = 100530.965
    fy = 444.44
    s = 250.00
  Vs,c1 is multiplied by   Col,c1 = 1.00
    s/d = 0.56818182
  Vs,c2 = 0.00 is calculated for section flange core, with:
    d = 200.00
    Av = 100530.965
    fy = 444.44
    s = 250.00
  Vs,c2 is multiplied by   Col,c2 = 0.00
    s/d = 1.25
  Vf ((11-3)-(11.4), ACI 440) = 372533.843
    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) = 707.00
  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 <= 930841.148
    bw = 450.00

Calculation of Shear Strength at edge 2, Vr2 = 1.1081E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 1.1081E+006
  knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 4.00
Mu = 761.1315
Vu = 0.00053663
d = 0.8*h = 600.00
Nu = 20792.011
Ag = 337500.00
From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 916401.511
where:
Vs,jacket = Vs,j1 + Vs,j2 = 837764.743
Vs,j1 = 523602.964 is calculated for section web jacket, with:
d = 600.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs,j1 is multiplied by Col,j1 = 1.00
s/d = 0.16666667
Vs,j2 = 314161.779 is calculated for section flange jacket, with:
d = 360.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs,j2 is multiplied by Col,j2 = 1.00
s/d = 0.27777778
Vs,core = Vs,c1 + Vs,c2 = 78636.768
Vs,c1 = 78636.768 is calculated for section web core, with:
d = 440.00
Av = 100530.965
fy = 444.44
s = 250.00
Vs,c1 is multiplied by Col,c1 = 1.00
s/d = 0.56818182
Vs,c2 = 0.00 is calculated for section flange core, with:
d = 200.00
Av = 100530.965
fy = 444.44
s = 250.00
Vs,c2 is multiplied by Col,c2 = 0.00
s/d = 1.25
Vf ((11-3)-(11.4), ACI 440) = 372533.843
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα 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) = 707.00
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 <= 930841.148
bw = 450.00

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

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

Constant Properties

Knowledge Factor,   = 0.90
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 555.55
##
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.02437
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
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 = -4.4410684E-008
EDGE -B-
Shear Force, Vb = 4.4410684E-008
BOTH EDGES
Axial Force, F = -20792.011

Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1539.38
     -Compression: Asl,com = 1539.38
         -Middle: Asl,mid = 3612.832

Calculation of Shear Capacity ratio , Ve/Vr = 0.39733369
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 646432.814
with
Mpr1 = Max(Mu1+ , Mu1-) = 9.6965E+008
  Mu1+ = 9.6965E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
  Mu1- = 9.6965E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 9.6965E+008
  Mu2+ = 9.6965E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
  Mu2- = 9.6965E+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 = 7.3807483E-006
Mu = 9.6965E+008
----
with full section properties:
  b = 450.00
  d = 907.00
  d' = 43.00
  v = 0.0015437
    N = 20792.011
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01209008
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: cu = 0.01209008
       we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx,   fy) = 0.04611842
     where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
     ----
       fx = 0.03444474
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
        bmax = 950.00
        hmax = 750.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
          bw = 450.00
        effective stress from (A.35), ff,e = 881.8461
     ----
       fy = 0.03444474
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
        bmax = 950.00
        hmax = 750.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
          bw = 450.00

effective stress from (A.35), ff,e = 881.8461

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 = 0.53375773

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

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

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

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

   "Theoretical Stress-Strain Model for Confined Concrete."

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

   Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and

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

   Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and

         is calculated by reducing all the dimensions of the area Aconf,max1 by a length

         equal to half the clear spacing between external hoops.

   AnoConf1 = 173066.667 is the unconfined external core area which is equal to   bi2/6 as defined at (A.2).

ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773

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

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

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

   "Theoretical Stress-Strain Model for Confined Concrete."

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

   Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and

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

   Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and

         is calculated by reducing all the dimensions of the area Aconf,max2 by a length

         equal to half the clear spacing between internal hoops.

   AnoConf2 = 110709.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).

psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578

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

----

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578

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

   Lstir1 (Length of stirrups along Y) = 2160.00

   Astir1 (stirrups area) = 78.53982

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

   Lstir2 (Length of stirrups along Y) = 1568.00

   Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307

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

   Lstir1 (Length of stirrups along X) = 2560.00

   Astir1 (stirrups area) = 78.53982

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

   Lstir2 (Length of stirrups along X) = 1968.00

   Astir2 (stirrups area) = 50.26548

Asec = 562500.00

s1 = 100.00

s2 = 250.00

fywe1 = 694.45

fywe2 = 555.55

fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00224367

   c = confinement factor = 1.02437

y1 = 0.00143155

sh1 = 0.00458096

ft1 = 458.0986

fy1 = 381.7488

su1 = 0.00550601

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

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
  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 = 381.7488
  with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 458.0986
fy2 = 381.7488
su2 = 0.00550601
  using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
    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 = 381.7488
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00143155
shv = 0.00458096
ftv = 452.7869
fyv = 377.3224
suv = 0.00550601
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.31005242
    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 = 377.3224
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04363047
2 = Asl,com/(b*d)*(fs2/fc) = 0.04363047
v = Asl,mid/(b*d)*(fsv/fc) = 0.10121073
and confined core properties:
b = 390.00
d = 877.00
d' = 13.00
fcc (5A.2, TBDY) = 33.80412
cc (5A.5, TBDY) = 0.00224367
  c = confinement factor = 1.02437
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05206495
2 = Asl,com/(b*d)*(fs2/fc) = 0.05206495
v = Asl,mid/(b*d)*(fsv/fc) = 0.12077642
Case/Assumption: Unconfinesd full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.17751206
Mu = MRc (4.14) = 9.6965E+008
u =   su (4.1) = 7.3807483E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
    ψ = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
    ψt = 1.00
    ψs = 0.80
    ψe = 1.00
  cb = 25.00
  Ktr = 1.37392
    Atr = Min(Atr_x,Atr_y) = 257.6106
    where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
    s = Max(s_external,s_internal) = 250.00
    n = 30.00

Calculation of Mu1-

Calculation of ultimate curvature ϕu according to 4.1, Biskinis/Fardis 2013:
  ϕu = 7.3807483E-006
Mu = 9.6965E+008
----
with full section properties:
  b = 450.00
  d = 907.00
  d' = 43.00
  v = 0.0015437
    N = 20792.011
  fc = 33.00
  ϵco (5A.5, TBDY) = 0.002
  Final value of ϵcu: ϵcu* = shear_factor * Max(ϵcu, ϵcc) = 0.01209008
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: ϵcu = 0.01209008
      ωwe ((5.4c), TBDY) = αse* ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.04611842
    where ωf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

      ωfx = 0.03444474
      Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
      af = 0.28545185
      with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
        bmax = 950.00
        hmax = 750.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
          bw = 450.00
        effective stress from (A.35), ff,e = 881.8461

      ωfy = 0.03444474
      Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
      af = 0.28545185
      with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
        bmax = 950.00
        hmax = 750.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
          bw = 450.00
        effective stress from (A.35), ff,e = 881.8461

        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 = 0.53375773
   ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
   The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
   of the rectangular sections confinement, which is expressed by (5.4d).
   The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
   "Theoretical Stress-Strain Model for Confined Concrete."
   J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
   Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
      is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
   Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
      is calculated by reducing all the dimensions of the area Aconf,max1 by a length
      equal to half the clear spacing between external hoops.
   AnoConf1 = 173066.667 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
   The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
   of the rectangular sections confinement, which is expressed by (5.4d).
   The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
   "Theoretical Stress-Strain Model for Confined Concrete."
   J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
   Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
      is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
   Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
      is calculated by reducing all the dimensions of the area Aconf,max2 by a length
      equal to half the clear spacing between internal hoops.
   AnoConf2 = 110709.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----
   psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
   psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
      Lstir1 (Length of stirrups along Y) = 2160.00
      Astir1 (stirrups area) = 78.53982
   psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
      Lstir2 (Length of stirrups along Y) = 1568.00
      Astir2 (stirrups area) = 50.26548
----
   psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
   psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
      Lstir1 (Length of stirrups along X) = 2560.00
      Astir1 (stirrups area) = 78.53982
   psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
      Lstir2 (Length of stirrups along X) = 1968.00
      Astir2 (stirrups area) = 50.26548

    Asec = 562500.00
    s1 = 100.00
    s2 = 250.00
   fywe1 = 694.45
   fywe2 = 555.55
   fce = 33.00
From ((5.A5), TBDY): cc = 0.00224367
   c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 458.0986
fy1 = 381.7488
su1 = 0.00550601
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.31005242
  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 = 381.7488
  with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 458.0986
fy2 = 381.7488
su2 = 0.00550601
  using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
  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 = 381.7488
  with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00143155
shv = 0.00458096
ftv = 452.7869
fyv = 377.3224
suv = 0.00550601
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.31005242
  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 = 377.3224
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04363047
2 = Asl,com/(b*d)*(fs2/fc) = 0.04363047
v = Asl,mid/(b*d)*(fsv/fc) = 0.10121073
and confined core properties:
b = 390.00
d = 877.00
d' = 13.00
fcc (5A.2, TBDY) = 33.80412
cc (5A.5, TBDY) = 0.00224367
  c = confinement factor = 1.02437
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05206495
2 = Asl,com/(b*d)*(fs2/fc) = 0.05206495
v = Asl,mid/(b*d)*(fsv/fc) = 0.12077642
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.17751206
Mu = MRc (4.14) = 9.6965E+008
u = su (4.1) = 7.3807483E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
  = 1
db = 16.66667

Mean strength value of all re-bars: fy = 655.558
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  t = 1.00
  s = 0.80
  e = 1.00
 cb = 25.00
 Ktr = 1.37392
  Atr = Min(Atr_x,Atr_y) = 257.6106
  where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
  s = Max(s_external,s_internal) = 250.00
  n = 30.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
 φu = 7.3807483E-006
Mu = 9.6965E+008
----
with full section properties:
 b = 450.00
 d = 907.00
 d' = 43.00
 v = 0.0015437
  N = 20792.011
 fc = 33.00
 εco (5A.5, TBDY) = 0.002
 Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.01209008
   The Shear_factor is considered equal to 1 (pure moment strength)
   From (5.4b), TBDY: εcu = 0.01209008
    ωwe ((5.4c), TBDY) = ρse*αsh,min*fywe/fce+Min(ωfx, ωfy) = 0.04611842
   where ωf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

    ωfx = 0.03444474
   Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
   αf = 0.28545185
   with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
     bmax = 950.00
     hmax = 750.00
     From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00451556
       bw = 450.00
     effective stress from (A.35), ff,e = 881.8461

    ωfy = 0.03444474
   Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
   αf = 0.28545185
   with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
     bmax = 950.00
     hmax = 750.00
     From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00451556
       bw = 450.00
     effective stress from (A.35), ff,e = 881.8461

     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 = 0.53375773
       αse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
       The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
       of the rectangular sections confinement, which is expressed by (5.4d).
       The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)

"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
        is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
        is calculated by reducing all the dimensions of the area Aconf,max1 by a length
        equal to half the clear spacing between external hoops.
AnoConf1 = 173066.667 is the unconfined external core area which is equal to   bi2/6 as defined at (A.2).
ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
    The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
    of the rectangular sections confinement, which is expressed by (5.4d).
    The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
    "Theoretical Stress-Strain Model for Confined Concrete."
    J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
        is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
        is calculated by reducing all the dimensions of the area Aconf,max2 by a length
        equal to half the clear spacing between internal hoops.
AnoConf2 = 110709.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

    ----
    psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
    psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
        Lstir1 (Length of stirrups along Y) = 2160.00
        Astir1 (stirrups area) = 78.53982
    psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
        Lstir2 (Length of stirrups along Y) = 1568.00
        Astir2 (stirrups area) = 50.26548

    ----
    psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
    psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
        Lstir1 (Length of stirrups along X) = 2560.00
        Astir1 (stirrups area) = 78.53982
    psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
        Lstir2 (Length of stirrups along X) = 1968.00
        Astir2 (stirrups area) = 50.26548

    Asec = 562500.00
    s1 = 100.00
    s2 = 250.00
    fywe1 = 694.45
    fywe2 = 555.55
    fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
    c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 458.0986
fy1 = 381.7488
su1 = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.31005242
    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 = 381.7488
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 458.0986

fy2 = 381.7488
su2 = 0.00550601
 using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
  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 = 381.7488
  with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
 yv = 0.00143155
 shv = 0.00458096
ftv = 452.7869
fyv = 377.3224
 suv = 0.00550601
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 lo/lou,min = lb/ld = 0.31005242
  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 = 377.3224
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.04363047
 2 = Asl,com/(b*d)*(fs2/fc) = 0.04363047
 v = Asl,mid/(b*d)*(fsv/fc) = 0.10121073
and confined core properties:
 b = 390.00
 d = 877.00
 d' = 13.00
 fcc (5A.2, TBDY) = 33.80412
  cc (5A.5, TBDY) = 0.00224367
   c = confinement factor = 1.02437
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.05206495
 2 = Asl,com/(b*d)*(fs2/fc) = 0.05206495
 v = Asl,mid/(b*d)*(fsv/fc) = 0.12077642
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.17751206
Mu = MRc (4.14) = 9.6965E+008
 u =   su (4.1) = 7.3807483E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
    = 1
 db = 16.66667
 Mean strength value of all re-bars: fy = 655.558
 Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
   t = 1.00
   s = 0.80
   e = 1.00

```
  cb = 25.00
  Ktr = 1.37392
   Atr = Min(Atr_x,Atr_y) = 257.6106
   where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
   s = Max(s_external,s_internal) = 250.00
   n = 30.00
----------------------------------------------------------------------------
----------------------------------------------------------------------------
----------------------------------------------------------------------------
Calculation of Mu2-
----------------------------------------------------------------------------


----------------------------------------------------------------------------
Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 7.3807483E-006
Mu = 9.6965E+008
----------------------------------------------------------------------------
with full section properties:
  b = 450.00
  d = 907.00
  d' = 43.00
  v = 0.0015437
    N = 20792.011
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of  cu:  cu* = shear_factor * Max( cu, cc) = 0.01209008
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY:  cu = 0.01209008
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min( fx,  fy) = 0.04611842
    where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ------------------------------------------------------------------
      fx = 0.03444474
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A4.4.3(6), pf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461
    ------------------------------------------------------------
      fy = 0.03444474
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A4.4.3(6), pf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461
    ------------------------------------------------------------
      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 = 0.53375773
        ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
              is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
        Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
              is calculated by reducing all the dimensions of the area Aconf,max1 by a length
```

equal to half the clear spacing between external hoops.

AnoConf1 = 173066.667 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).

ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773

The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.

Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.

Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.

AnoConf2 = 110709.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).

psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578

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

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
    Lstir1 (Length of stirrups along Y) = 2160.00
    Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
    Lstir2 (Length of stirrups along Y) = 1568.00
    Astir2 (stirrups area) = 50.26548
----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
    Lstir1 (Length of stirrups along X) = 2560.00
    Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
    Lstir2 (Length of stirrups along X) = 1968.00
    Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 458.0986
fy1 = 381.7488
su1 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 381.7488
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 458.0986
fy2 = 381.7488
su2 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242

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 = 381.7488
 with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
 yv = 0.00143155
 shv = 0.00458096
ftv = 452.7869
fyv = 377.3224
 suv = 0.00550601
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 lo/lou,min = lb/ld = 0.31005242
 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 = 377.3224
 with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.04363047
 2 = Asl,com/(b*d)*(fs2/fc) = 0.04363047
 v = Asl,mid/(b*d)*(fsv/fc) = 0.10121073
and confined core properties:
 b = 390.00
 d = 877.00
 d' = 13.00
 fcc (5A.2, TBDY) = 33.80412
 cc (5A.5, TBDY) = 0.00224367
 c = confinement factor = 1.02437
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.05206495
 2 = Asl,com/(b*d)*(fs2/fc) = 0.05206495
 v = Asl,mid/(b*d)*(fsv/fc) = 0.12077642
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.17751206
Mu = MRc (4.14) = 9.6965E+008
 u = su (4.1) = 7.3807483E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 = 1
 db = 16.66667
 Mean strength value of all re-bars: fy = 655.558
 Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
 t = 1.00
 s = 0.80
 e = 1.00
 cb = 25.00
 Ktr = 1.37392
 Atr = Min(Atr_x,Atr_y) = 257.6106
 where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
 s = Max(s_external,s_internal) = 250.00
 n = 30.00

```
--------------------------------------------------------------------
--------------------------------------------------------------------
--------------------------------------------------------------------
--------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.6269E+006
--------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 1.6269E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
   VCol0 = 1.6269E+006
   knl = 1 (zero step-static loading)
----------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
----------------------------------------------------------------
    = 1 (normal-weight concrete)
   Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
   M/Vd = 2.00
      Mu = 0.62237178
      Vu = 4.4410684E-008
   d = 0.8*h = 760.00
   Nu = 20792.011
   Ag = 427500.00
   From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 1.0846E+006
   where:
   Vs,jacket = Vs,j1 + Vs,j2 = 977392.20
    Vs,j1 = 314161.779 is calculated for section web jacket, with:
       d = 360.00
       Av = 157079.633
       fy = 555.56
       s = 100.00
    Vs,j1 is multiplied by   Col,j1 = 1.00
       s/d = 0.27777778
    Vs,j2 = 663230.422 is calculated for section flange jacket, with:
       d = 760.00
       Av = 157079.633
       fy = 555.56
       s = 100.00
    Vs,j2 is multiplied by   Col,j2 = 1.00
       s/d = 0.13157895
   Vs,core = Vs,c1 + Vs,c2 = 107231.957
    Vs,c1 = 0.00 is calculated for section web core, with:
       d = 200.00
       Av = 100530.965
       fy = 444.44
       s = 250.00
    Vs,c1 is multiplied by   Col,c1 = 0.00
       s/d = 1.25
    Vs,c2 = 107231.957 is calculated for section flange core, with:
       d = 600.00
       Av = 100530.965
       fy = 444.44
       s = 250.00
    Vs,c2 is multiplied by   Col,c2 = 1.00
       s/d = 0.41666667
    Vf ((11-3)-(11.4), ACI 440) = 477918.239
       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) = 907.00
    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 <= 1.1791E+006
        bw = 450.00

Calculation of Shear Strength at edge 2, Vr2 = 1.6269E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
   VCol0 = 1.6269E+006
   knl = 1 (zero step-static loading)

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

     = 1 (normal-weight concrete)
   Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
   M/Vd = 2.00
      Mu = 0.62124232
      Vu = 4.4410684E-008
    d = 0.8*h = 760.00
    Nu = 20792.011
    Ag = 427500.00
    From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 1.0846E+006
    where:
   Vs,jacket = Vs,j1 + Vs,j2 = 977392.20
    Vs,j1 = 314161.779 is calculated for section web jacket, with:
      d = 360.00
      Av = 157079.633
      fy = 555.56
      s = 100.00
    Vs,j1 is multiplied by Col,j1 = 1.00
      s/d = 0.27777778
    Vs,j2 = 663230.422 is calculated for section flange jacket, with:
      d = 760.00
      Av = 157079.633
      fy = 555.56
      s = 100.00
    Vs,j2 is multiplied by Col,j2 = 1.00
      s/d = 0.13157895
   Vs,core = Vs,c1 + Vs,c2 = 107231.957
    Vs,c1 = 0.00 is calculated for section web core, with:
      d = 200.00
      Av = 100530.965
      fy = 444.44
      s = 250.00
    Vs,c1 is multiplied by Col,c1 = 0.00
      s/d = 1.25
    Vs,c2 = 107231.957 is calculated for section flange core, with:
      d = 600.00
      Av = 100530.965
      fy = 444.44
      s = 250.00
    Vs,c2 is multiplied by Col,c2 = 1.00
      s/d = 0.41666667
    Vf ((11-3)-(11.4), ACI 440) = 477918.239
      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) = 907.00

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 <= 1.1791E+006
    bw = 450.00

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

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

Constant Properties

Knowledge Factor,   = 0.90
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lb = 300.00
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 = 34209.595
Shear Force, V2 = -8272.465
Shear Force, V3 = -17.12416

Axial Force, F = -21341.949
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1539.38
     -Compression: Asl,com = 2475.575
        -Middle: Asl,mid = 2676.637
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,jacket = 1231.504
     -Compression: Asl,com,jacket = 1859.823
        -Middle: Asl,mid,jacket = 2060.885
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,core = 307.8761
     -Compression: Asl,com,core = 615.7522
        -Middle: Asl,mid,core = 615.7522
Mean Diameter of Tension Reinforcement, DbL = 16.57143

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity   u,R =   * u = 0.00191518
  u = y + p = 0.00212798

 - Calculation of y -
----
 y = (My*Ls/3)/EIeff = 0.00212798 ((4.29),Biskinis Phd))
  My = 5.5414E+008
  Ls = M/V (with Ls > 0.1*L and Ls < 2*L) = 1997.739
  From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7341E+014
     factor = 0.30
        Ag = 562500.00
        Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333
        N = 21341.949
     Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7803E+014

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7 -

Assuming neutral axis within flange (y < t/d, compression zone rectangular) with:
flange width, b = 950.00
web width, bw = 450.00
flange thickness, t = 450.00
----
  y = Min(y_ten, y_com)
  y_ten = 3.1142058E-006
  with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 352.1657
     d = 707.00
      y = 0.20025732
     A = 0.01005314
     B = 0.00472011
      with pt = 0.00229194
         pc = 0.00368581
         pv = 0.00398517
         N = 21341.949
         b = 950.00
          " = 0.06082037
  y_comp = 1.5783736E-005
  with fc* (12.3, (ACI 440)) = 33.25688
     fc = 33.00
     fl = 0.43533893
     b = bmax = 950.00
     h = hmax = 750.00

```
       Ag = 0.5625
          g = pt + pc + pv = 0.00996292
       rc = 40.00
       Ae/Ac = 0.30198841
       Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
     effective strain from (12.5) and (12.12), efe = 0.004
      fu = 0.01
     Ef = 64828.00
    Ec = 26999.444
     y = 0.19868723
    A = 0.00989126
    B = 0.00462988
     with Es = 200000.00
CONFIRMATION:  y = 0.19960317 < t/d
------------------------------------------------------------
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Lap Length: ld/ld,min = 0.38756552
lb = 300.00
ld = 774.0627
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
     = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 524.4464
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
    t = 1.00
    s = 0.80
    e = 1.00
  cb = 25.00
  Ktr = 1.37392
   Atr = Min(Atr_x,Atr_y) = 257.6106
   where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
   s = Max(s_external,s_internal) = 250.00
   n = 30.00


------------------------------------------------------------
 - Calculation of  p -
------------------------------------------------------------
From table 10-8:  p = 0.00
with:
 - Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
   shear control ratio VyE/VCol0E = 0.56344875
   d = d_external = 707.00
   s = s_external = 0.00
 -  t =   s1 +   s2 + 2*tf/bw*(ffe/fs) = 0.00568407
   jacket:  s1 = Av1*Lstir1/(s1*Ag) = 0.00301593
        Av1 = 78.53982, is the area of every stirrup parallel to loading (shear) direction
        Lstir1 = 2160.00, is the total Length of all stirrups parallel to loading (shear) direction
        s1 = 100.00
   core:   s2 = Av2*Lstir2/(s2*Ag) = 0.00056047
        Av2 = 50.26548, is the area of every stirrup parallel to loading (shear) direction
        Lstir2 = 1568.00, is the total Length of all stirrups parallel to loading (shear) direction
        s2 = 250.00
   The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
   where   f = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises   f to steel strength
   All these variables have already been given in Shear control ratio calculation.
   For the normalisation fs of jacket is used.
    NUD = 21341.949
    Ag = 562500.00
    f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 26.93333
    fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein =
529.9972
    fytE = (fy_ext_Trans_Reinf*  s1+fy_int_Trans_Reinf*  s2)/(  s1+  s2) = 538.146
pl = Area_Tot_Long_Rein/(b*d) = 0.00996292
```
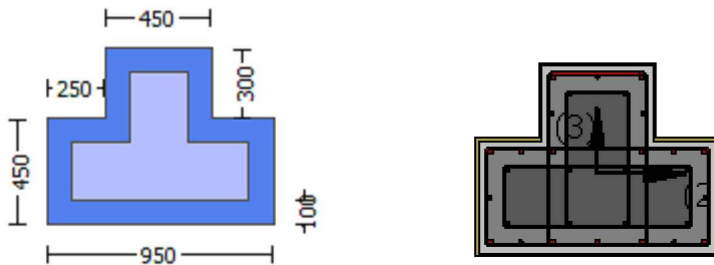
b = 950.00
d = 707.00
f'cE = 26.93333

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

Calculation No. 3

column C1, Floor 1

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

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (3)

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

Constant Properties

Knowledge Factor,   = 0.90
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column

Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of y for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.44
##
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = lb = 300.00
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 = 34209.595
Shear Force, Va = -17.12416
EDGE -B-
Bending Moment, Mb = 18052.15
Shear Force, Vb = 17.12416
BOTH EDGES
Axial Force, F = -21341.949
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
      -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1539.38
      -Compression: Asl,com = 2475.575
        -Middle: Asl,mid = 2676.637
Mean Diameter of Tension Reinforcement, DbL,ten = 16.57143

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR =   *Vn = 904932.569
Vn ((10.3), ASCE 41-17) = knl*VColO = 1.0055E+006
   VCol = 1.0055E+006

```
knl = 1.00
    displacement_ductility_demand = 0.00568943
------------------------------------------------------------
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 = 20.80, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 3.32956
    Mu = 34209.595
    Vu = 17.12416
  d = 0.8*h = 600.00
  Nu = 21341.949
  Ag = 337500.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 824756.036
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 753982.237
  Vs,j1 = 471238.898 is calculated for section web jacket, with:
    d = 600.00
    Av = 157079.633
    fy = 500.00
    s = 100.00
  Vs,j1 is multiplied by   Col,j1 = 1.00
    s/d = 0.16666667
  Vs,j2 = 282743.339 is calculated for section flange jacket, with:
    d = 360.00
    Av = 157079.633
    fy = 500.00
    s = 100.00
  Vs,j2 is multiplied by   Col,j2 = 1.00
    s/d = 0.27777778
  Vs,core = Vs,c1 + Vs,c2 = 70773.799
  Vs,c1 = 70773.799 is calculated for section web core, with:
    d = 440.00
    Av = 100530.965
    fy = 400.00
    s = 250.00
  Vs,c1 is multiplied by   Col,c1 = 1.00
    s/d = 0.56818182
  Vs,c2 = 0.00 is calculated for section flange core, with:
    d = 200.00
    Av = 100530.965
    fy = 400.00
    s = 250.00
  Vs,c2 is multiplied by   Col,c2 = 0.00
    s/d = 1.25
  Vf ((11-3)-(11.4), ACI 440) = 372533.843
    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) = 707.00
  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 <= 818016.733
    bw = 450.00
------------------------------------------------------------

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

displacement_ductility_demand is calculated as θ / θy

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

From analysis, chord rotation θ = 1.2106985E-005
 θy = (My*Ls/3)/EIeff = 0.00212798 ((4.29),Biskinis Phd))
  My = 5.5414E+008
  Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1997.739
  From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7341E+014
    factor = 0.30
      Ag = 562500.00
      Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333
      N = 21341.949
    Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7803E+014

Calculation of Yielding Moment My

Calculation of φy and My according to Annex 7 -

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

  φy = Min(φy_ten, φy_com)
  φy_ten = 3.1142058E-006
  with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 352.1657
    d = 707.00
     ξy = 0.20025732
     A = 0.01005314
     B = 0.00472011
     with pt = 0.00229194
        pc = 0.00368581
        pv = 0.00398517
        N = 21341.949
        b = 950.00
        " = 0.06082037
  φy_comp = 1.5783736E-005
 with fc* (12.3, (ACI 440)) = 33.25688
    fc = 33.00
    fl = 0.43533893
    b = bmax = 950.00
    h = hmax = 750.00
    Ag = 0.5625
       ρg = pt + pc + pv = 0.00996292
     rc = 40.00
     Ae/Ac = 0.30198841
     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
    ξy = 0.19868723
   A = 0.0098926
   B = 0.00462988
    with Es = 200000.00
CONFIRMATION: ξy = 0.19960317 < t/d

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.38756552
lb = 300.00

ld = 774.0627
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
   = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 524.4464
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
    t = 1.00
    s = 0.80
    e = 1.00
  cb = 25.00
  Ktr = 1.37392
  Atr = Min(Atr_x,Atr_y) = 257.6106
  where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
  s = Max(s_external,s_internal) = 250.00
  n = 30.00

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

Calculation No. 4

column C1, Floor 1

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

Analysis: Uniform +X

Check: Chord rotation capacity (u)

Edge: Start

Local Axis: (3)

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

Constant Properties

Knowledge Factor, = 0.90
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 555.55
##
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.02437
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
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 = -0.00053663
EDGE -B-
Shear Force, Vb = 0.00053663
BOTH EDGES
Axial Force, F = -20792.011
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
    -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 1539.38
    -Compression: Asl,com = 2475.575
        -Middle: Asl,mid = 2676.637

Calculation of Shear Capacity ratio , Ve/Vr = 0.56344875
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 624335.951
with
Mpr1 = Max(Mu1+ , Mu1-) = 9.3650E+008
  Mu1+ = 6.7320E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
  Mu1- = 9.3650E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 9.3650E+008
  Mu2+ = 6.7320E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
  Mu2- = 9.3650E+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 = 9.1136953E-006
Mu = 6.7320E+008
----
with full section properties:
  b = 950.00
  d = 707.00
  d' = 43.00
  v = 0.00093808
    N = 20792.011
  fc = 33.00
    co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01209008
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.01209008
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+ Min(fx, fy) = 0.04611842
    where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----
      fx = 0.03444474
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A4.4.3(6), pf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461
    ----
      fy = 0.03444474
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A4.4.3(6), pf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

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

The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max1 by a length
equal to half the clear spacing between external hoops.
AnoConf1 = 173066.667 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 110709.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 458.0986
fy1 = 381.7488
su1 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 381.7488
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.00143155
 sh2 = 0.00458096
ft2 = 453.4475
fy2 = 377.8729
 su2 = 0.00550601
   using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
    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 = 377.8729
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
 yv = 0.00143155
 shv = 0.00458096
ftv = 455.2307
fyv = 379.359
 suv = 0.00550601
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.31005242
    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 = 379.359
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.02651348
   2 = Asl,com/(b*d)*(fs2/fc) = 0.04220509
   v = Asl,mid/(b*d)*(fsv/fc) = 0.04581238
and confined core properties:
 b = 890.00
 d = 677.00
 d' = 13.00
 fcc (5A.2, TBDY) = 33.80412
  cc (5A.5, TBDY) = 0.00224367
    c = confinement factor = 1.02437
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.029555
   2 = Asl,com/(b*d)*(fs2/fc) = 0.0470467
   v = Asl,mid/(b*d)*(fsv/fc) = 0.0510678
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.14547789
Mu = MRc (4.14) = 6.7320E+008
 u =   su (4.1) = 9.1136953E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
    = 1
 db = 16.66667
 Mean strength value of all re-bars: fy = 655.558
 Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)

```
        t = 1.00
        s = 0.80
        e = 1.00
       cb = 25.00
      Ktr = 1.37392
      Atr = Min(Atr_x,Atr_y) = 257.6106
      where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
        s = Max(s_external,s_internal) = 250.00
        n = 30.00
```

Calculation of Mu1-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
  u = 9.8526632E-006
Mu = 9.3650E+008

----

with full section properties:
  b = 450.00
  d = 707.00
  d' = 43.00
  v = 0.00198039
    N = 20792.011
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01209008
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.01209008
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.04611842
    where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
      ----
      fx = 0.03444474
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2 + (hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A4.4.3(6), pf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461
      ----
      fy = 0.03444474
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2 + (hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A4.4.3(6), pf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

      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 = 0.53375773
        ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and

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

Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and is calculated by reducing all the dimensions of the area Aconf,max1 by a length equal to half the clear spacing between external hoops.

AnoConf1 = 173066.667 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).

ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773

The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization of the rectangular sections confinement, which is expressed by (5.4d).

The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988) "Theoretical Stress-Strain Model for Confined Concrete." J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.

Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.

Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and is calculated by reducing all the dimensions of the area Aconf,max2 by a length equal to half the clear spacing between internal hoops.

AnoConf2 = 110709.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).

psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578

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

----

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
   Lstir1 (Length of stirrups along Y) = 2160.00
   Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
   Lstir2 (Length of stirrups along Y) = 1568.00
   Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
   Lstir1 (Length of stirrups along X) = 2560.00
   Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
   Lstir2 (Length of stirrups along X) = 1968.00
   Astir2 (stirrups area) = 50.26548

   Asec = 562500.00
   s1 = 100.00
   s2 = 250.00
  fywe1 = 694.45
  fywe2 = 555.55
  fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
  c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 453.4475
fy1 = 377.8729
su1 = 0.00550601
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 lo/lou,min = lb/ld = 0.31005242
 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 = 377.8729
 with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 458.0986
fy2 = 381.7488
su2 = 0.00550601
 using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
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 = 381.7488
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00143155
shv = 0.00458096
ftv = 455.2307
fyv = 379.359
suv = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 379.359
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.08909964
2 = Asl,com/(b*d)*(fs2/fc) = 0.05597289
v = Asl,mid/(b*d)*(fsv/fc) = 0.09671502
and confined core properties:
b = 390.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 33.80412
cc (5A.5, TBDY) = 0.00224367
c = confinement factor = 1.02437
1 = Asl,ten/(b*d)*(fs1/fc) = 0.10736299
2 = Asl,com/(b*d)*(fs2/fc) = 0.06744603
v = Asl,mid/(b*d)*(fsv/fc) = 0.11653935
Case/Assumption: Unconfinesd full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.20956863
Mu = MRc (4.14) = 9.3650E+008
u = su (4.1) = 9.8526632E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 16.66667
Mean strength value of all re-bars: fy = 655.558
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
t = 1.00
s = 0.80
e = 1.00
cb = 25.00
Ktr = 1.37392
Atr = Min(Atr_x,Atr_y) = 257.6106

where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis

s = Max(s_external,s_internal) = 250.00

n = 30.00

Calculation of Mu2+

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

φu = 9.1136953E-006

Mu = 6.7320E+008

----

with full section properties:

b = 950.00

d = 707.00

d' = 43.00

v = 0.00093808

N = 20792.011

fc = 33.00

εco (5A.5, TBDY) = 0.002

Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.01209008

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

From (5.4b), TBDY: εcu = 0.01209008

we ((5.4c), TBDY) = αse* ρsh,min*fywe/fce+Min(Δfx, Δfy) = 0.04611842

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

Δfx = 0.03444474

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

αf = 0.28545185

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

bmax = 950.00

hmax = 750.00

From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00451556

bw = 450.00

effective stress from (A.35), ff,e = 881.8461

Δfy = 0.03444474

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

αf = 0.28545185

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

bmax = 950.00

hmax = 750.00

From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00451556

bw = 450.00

effective stress from (A.35), ff,e = 881.8461

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 = 0.53375773

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

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

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

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

"Theoretical Stress-Strain Model for Confined Concrete."

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

Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and

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

Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and

is calculated by reducing all the dimensions of the area Aconf,max1 by a length

equal to half the clear spacing between external hoops.

AnoConf1 = 173066.667 is the unconfined external core area which is equal to Σbi2/6 as defined at (A.2).

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

The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 110709.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548

----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 458.0986
fy1 = 381.7488
su1 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 381.7488
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 453.4475
fy2 = 377.8729
su2 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
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 = 377.8729
 with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
 yv = 0.00143155
 shv = 0.00458096
ftv = 455.2307
fyv = 379.359
 suv = 0.00550601
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 lo/lou,min = lb/ld = 0.31005242
 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 = 379.359
 with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.02651348
 2 = Asl,com/(b*d)*(fs2/fc) = 0.04220509
 v = Asl,mid/(b*d)*(fsv/fc) = 0.04581238
and confined core properties:
 b = 890.00
 d = 677.00
 d' = 13.00
 fcc (5A.2, TBDY) = 33.80412
 cc (5A.5, TBDY) = 0.00224367
 c = confinement factor = 1.02437
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.029555
 2 = Asl,com/(b*d)*(fs2/fc) = 0.0470467
 v = Asl,mid/(b*d)*(fsv/fc) = 0.0510678
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.14547789
Mu = MRc (4.14) = 6.7320E+008
 u = su (4.1) = 9.1136953E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 = 1
 db = 16.66667
 Mean strength value of all re-bars: fy = 655.558
 Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
 t = 1.00
 s = 0.80
 e = 1.00
 cb = 25.00
 Ktr = 1.37392
 Atr = Min(Atr_x,Atr_y) = 257.6106
 where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
 s = Max(s_external,s_internal) = 250.00
 n = 30.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 9.8526632E-006
Mu = 9.3650E+008
----
with full section properties:
  b = 450.00
  d = 707.00
  d' = 43.00
  ν = 0.00198039
    N = 20792.011
  fc = 33.00
  εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.01209008
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.01209008
      ωwe ((5.4c), TBDY) = αse*ρsh,min*fywe/fce+Min(αfx, αfy) = 0.04611842
    where αf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

      αfx = 0.03444474
    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
    αf = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

      αfy = 0.03444474
    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
    αf = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

      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 = 0.53375773
        αse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
                is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
        Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
                is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                equal to half the clear spacing between external hoops.
        AnoConf1 = 173066.667 is the unconfined external core area which is equal to Σbi2/6 as defined at (A.2).
      αse2 (>=αse1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and

is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 110709.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
   Lstir1 (Length of stirrups along Y) = 2160.00
   Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
   Lstir2 (Length of stirrups along Y) = 1568.00
   Astir2 (stirrups area) = 50.26548
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
   Lstir1 (Length of stirrups along X) = 2560.00
   Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
   Lstir2 (Length of stirrups along X) = 1968.00
   Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
   c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 453.4475
fy1 = 377.8729
su1 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 377.8729
 with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 458.0986
fy2 = 381.7488
su2 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
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 = 381.7488
 with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00143155
shv = 0.00458096

ftv = 455.2307
fyv = 379.359
  suv = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.31005242
      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 = 379.359
      with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.08909964
    2 = Asl,com/(b*d)*(fs2/fc) = 0.05597289
    v = Asl,mid/(b*d)*(fsv/fc) = 0.09671502
and confined core properties:
  b = 390.00
  d = 677.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.80412
    cc (5A.5, TBDY) = 0.00224367
      c = confinement factor = 1.02437
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.10736299
    2 = Asl,com/(b*d)*(fs2/fc) = 0.06744603
    v = Asl,mid/(b*d)*(fsv/fc) = 0.11653935
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.20956863
Mu = MRc (4.14) = 9.3650E+008
  u =   su (4.1) = 9.8526632E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
    = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
    t = 1.00
    s = 0.80
    e = 1.00
  cb = 25.00
  Ktr = 1.37392
   Atr = Min(Atr_x,Atr_y) = 257.6106
   where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
   s = Max(s_external,s_internal) = 250.00
   n = 30.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.1081E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.1081E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 1.1081E+006

knl = 1 (zero step-static loading)

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

  = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
    Mu = 761.1315
    Vu = 0.00053663
  d = 0.8*h = 600.00
  Nu = 20792.011
  Ag = 337500.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 916401.511
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 837764.743
  Vs,j1 = 523602.964 is calculated for section web jacket, with:
    d = 600.00
    Av = 157079.633
    fy = 555.56
    s = 100.00
  Vs,j1 is multiplied by Col,j1 = 1.00
    s/d = 0.16666667
  Vs,j2 = 314161.779 is calculated for section flange jacket, with:
    d = 360.00
    Av = 157079.633
    fy = 555.56
    s = 100.00
  Vs,j2 is multiplied by Col,j2 = 1.00
    s/d = 0.27777778
  Vs,core = Vs,c1 + Vs,c2 = 78636.768
  Vs,c1 = 78636.768 is calculated for section web core, with:
    d = 440.00
    Av = 100530.965
    fy = 444.44
    s = 250.00
  Vs,c1 is multiplied by Col,c1 = 1.00
    s/d = 0.56818182
  Vs,c2 = 0.00 is calculated for section flange core, with:
    d = 200.00
    Av = 100530.965
    fy = 444.44
    s = 250.00
  Vs,c2 is multiplied by Col,c2 = 0.00
    s/d = 1.25
  Vf ((11-3)-(11.4), ACI 440) = 372533.843
    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) = 707.00
  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 <= 930841.148
    bw = 450.00

Calculation of Shear Strength at edge 2, Vr2 = 1.1081E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0

VCol0 = 1.1081E+006
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 4.00
  Mu = 761.1315
  Vu = 0.00053663
d = 0.8*h = 600.00
Nu = 20792.011
Ag = 337500.00
From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 916401.511
where:
Vs,jacket = Vs,j1 + Vs,j2 = 837764.743
Vs,j1 = 523602.964 is calculated for section web jacket, with:
  d = 600.00
  Av = 157079.633
  fy = 555.56
  s = 100.00
Vs,j1 is multiplied by λCol,j1 = 1.00
  s/d = 0.16666667
Vs,j2 = 314161.779 is calculated for section flange jacket, with:
  d = 360.00
  Av = 157079.633
  fy = 555.56
  s = 100.00
Vs,j2 is multiplied by λCol,j2 = 1.00
  s/d = 0.27777778
Vs,core = Vs,c1 + Vs,c2 = 78636.768
Vs,c1 = 78636.768 is calculated for section web core, with:
  d = 440.00
  Av = 100530.965
  fy = 444.44
  s = 250.00
Vs,c1 is multiplied by λCol,c1 = 1.00
  s/d = 0.56818182
Vs,c2 = 0.00 is calculated for section flange core, with:
  d = 200.00
  Av = 100530.965
  fy = 444.44
  s = 250.00
Vs,c2 is multiplied by λCol,c2 = 0.00
  s/d = 1.25
Vf ((11-3)-(11.4), ACI 440) = 372533.843
  ψ_f = 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) = 707.00
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 <= 930841.148
  bw = 450.00

End Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1

At local axis: 3

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

Constant Properties

Knowledge Factor,   = 0.90
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 555.55
##
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.02437
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
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 = -4.4410684E-008
EDGE -B-

Shear Force, Vb = 4.4410684E-008
BOTH EDGES
Axial Force, F = -20792.011
Longitudinal Reinforcement Area Distribution (in 2 divisions)
    -Tension: Aslt = 0.00
  -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
    -Tension: Asl,ten = 1539.38
  -Compression: Asl,com = 1539.38
    -Middle: Asl,mid = 3612.832

Calculation of Shear Capacity ratio , Ve/Vr = 0.39733369
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 646432.814
with
Mpr1 = Max(Mu1+ , Mu1-) = 9.6965E+008
  Mu1+ = 9.6965E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
  Mu1- = 9.6965E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 9.6965E+008
  Mu2+ = 9.6965E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
  Mu2- = 9.6965E+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 = 7.3807483E-006
Mu = 9.6965E+008
----
with full section properties:
 b = 450.00
 d = 907.00
 d' = 43.00
 ν = 0.0015437
   N = 20792.011
 fc = 33.00
  εco (5A.5, TBDY) = 0.002
 Final value of εcu: εcu^* = shear_factor * Max(εcu, εcc) = 0.01209008
   The Shear_factor is considered equal to 1 (pure moment strength)
   From (5.4b), TBDY: εcu = 0.01209008
     ωwe ((5.4c), TBDY) = $\alpha se^* \rho sh,min*fywe/fce+Min(\omega fx, \omega fy)$ = 0.04611842
   where $\omega f = \alpha f*\rho f*ffe/fce$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

     ωfx = 0.03444474
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
       bmax = 950.00
       hmax = 750.00
       From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00451556
         bw = 450.00
       effective stress from (A.35), ff,e = 881.8461

     ωfy = 0.03444474
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
       bmax = 950.00

```
        hmax = 750.00
        From EC8 A 4.4.3(6), pf = 2tf/bw = 0.00451556
           bw = 450.00
        effective stress from (A.35), ff,e = 881.8461
     ----------------------------------------------------------------
        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 = 0.53375773
           ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
           The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
           of the rectangular sections confinement, which is expressed by (5.4d).
           The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
           "Theoretical Stress-Strain Model for Confined Concrete."
           J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
           Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
                   is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
           Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
                   is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                   equal to half the clear spacing between external hoops.
           AnoConf1 = 173066.667 is the unconfined external core area which is equal to   bi2/6 as defined at (A.2).
        ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
           The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
           of the rectangular sections confinement, which is expressed by (5.4d).
           The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
           "Theoretical Stress-Strain Model for Confined Concrete."
           J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
           Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
                   is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
           Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
                   is calculated by reducing all the dimensions of the area Aconf,max2 by a length
                   equal to half the clear spacing between internal hoops.
           AnoConf2 = 110709.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
        psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
     Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
     ----------------------------------------------------------------
        psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
           Lstir1 (Length of stirrups along Y) = 2160.00
           Astir1 (stirrups area) = 78.53982
        psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
           Lstir2 (Length of stirrups along Y) = 1568.00
           Astir2 (stirrups area) = 50.26548
     ----------------------------------------------------------------
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
           Lstir1 (Length of stirrups along X) = 2560.00
           Astir1 (stirrups area) = 78.53982
        psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
           Lstir2 (Length of stirrups along X) = 1968.00
           Astir2 (stirrups area) = 50.26548
     ----------------------------------------------------------------
        Asec = 562500.00
        s1 = 100.00
        s2 = 250.00
       fywe1 = 694.45
       fywe2 = 555.55
       fce  = 33.00
     From ((5.A5), TBDY), TBDY:  cc = 0.00224367
        c  = confinement factor = 1.02437
   y1 = 0.00143155
  sh1 = 0.00458096
 ft1 = 458.0986
 fy1 = 381.7488
```

su1 = 0.00550601
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.31005242
     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 = 381.7488
       with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
   y2 = 0.00143155
   sh2 = 0.00458096
 ft2 = 458.0986
 fy2 = 381.7488
   su2 = 0.00550601
   using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
     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 = 381.7488
       with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
   yv = 0.00143155
   shv = 0.00458096
 ftv = 452.7869
 fyv = 377.3224
   suv = 0.00550601
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.31005242
     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 = 377.3224
       with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.04363047
   2 = Asl,com/(b*d)*(fs2/fc) = 0.04363047
   v = Asl,mid/(b*d)*(fsv/fc) = 0.10121073
and confined core properties:
   b = 390.00
   d = 877.00
   d' = 13.00
   fcc (5A.2, TBDY) = 33.80412
     cc (5A.5, TBDY) = 0.00224367
       c = confinement factor = 1.02437
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.05206495
     2 = Asl,com/(b*d)*(fs2/fc) = 0.05206495
     v = Asl,mid/(b*d)*(fsv/fc) = 0.12077642
Case/Assumption: Unconfinesd full section - Steel rupture
   ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.17751206
Mu = MRc (4.14) = 9.6965E+008
   u =   su (4.1) = 7.3807483E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
   = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
    t = 1.00
    s = 0.80
    e = 1.00
  cb = 25.00
  Ktr = 1.37392
   Atr = Min(Atr_x,Atr_y) = 257.6106
   where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
   s = Max(s_external,s_internal) = 250.00
   n = 30.00

Calculation of Mu1-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 7.3807483E-006
Mu = 9.6965E+008
----
with full section properties:
  b = 450.00
  d = 907.00
  d' = 43.00
  v = 0.0015437
    N = 20792.011
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01209008
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.01209008
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.04611842
    where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----
      fx = 0.03444474
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461
    ----
      fy = 0.03444474
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

      R = 40.00

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

$fu,f = 1055.00$

$Ef = 64828.00$

$u,f = 0.015$

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

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

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

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

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

"Theoretical Stress-Strain Model for Confined Concrete."

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

Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and

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

Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and

is calculated by reducing all the dimensions of the area Aconf,max1 by a length

equal to half the clear spacing between external hoops.

AnoConf1 = 173066.667 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).

ase2 $(>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773$

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

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

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

"Theoretical Stress-Strain Model for Confined Concrete."

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

Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and

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

Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and

is calculated by reducing all the dimensions of the area Aconf,max2 by a length

equal to half the clear spacing between internal hoops.

AnoConf2 = 110709.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).

psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578

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

----

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578

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

Lstir1 (Length of stirrups along Y) = 2160.00

Astir1 (stirrups area) = 78.53982

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

Lstir2 (Length of stirrups along Y) = 1568.00

Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307

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

Lstir1 (Length of stirrups along X) = 2560.00

Astir1 (stirrups area) = 78.53982

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

Lstir2 (Length of stirrups along X) = 1968.00

Astir2 (stirrups area) = 50.26548

Asec = 562500.00

s1 = 100.00

s2 = 250.00

fywe1 = 694.45

fywe2 = 555.55

fce = 33.00

From $((5.A5), TBDY), TBDY: cc = 0.00224367$

c = confinement factor = 1.02437

y1 = 0.00143155

sh1 = 0.00458096

ft1 = 458.0986

fy1 = 381.7488

su1 = 0.00550601

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

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/ld = 0.31005242

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 = 381.7488
 with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 458.0986
fy2 = 381.7488
su2 = 0.00550601
 using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
 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 = 381.7488
 with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00143155
shv = 0.00458096
ftv = 452.7869
fyv = 377.3224
suv = 0.00550601
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 lo/lou,min = lb/ld = 0.31005242
 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 = 377.3224
 with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04363047
2 = Asl,com/(b*d)*(fs2/fc) = 0.04363047
v = Asl,mid/(b*d)*(fsv/fc) = 0.10121073
and confined core properties:
b = 390.00
d = 877.00
d' = 13.00
fcc (5A.2, TBDY) = 33.80412
 cc (5A.5, TBDY) = 0.00224367
  c = confinement factor = 1.02437
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.05206495
 2 = Asl,com/(b*d)*(fs2/fc) = 0.05206495
 v = Asl,mid/(b*d)*(fsv/fc) = 0.12077642
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.17751206
Mu = MRc (4.14) = 9.6965E+008
 u =   su (4.1) = 7.3807483E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783

Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
   = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
    t = 1.00
   s = 0.80
   e = 1.00
  cb = 25.00
  Ktr = 1.37392
   Atr = Min(Atr_x,Atr_y) = 257.6106
   where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
   s = Max(s_external,s_internal) = 250.00
   n = 30.00

Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 7.3807483E-006
Mu = 9.6965E+008
----
with full section properties:
  b = 450.00
  d = 907.00
  d' = 43.00
  v = 0.0015437
   N = 20792.011
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01209008
   The Shear_factor is considered equal to 1 (pure moment strength)
   From (5.4b), TBDY: cu = 0.01209008
    we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx,   fy) = 0.04611842
   where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
   ----
    fx = 0.03444474
   Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
   af = 0.28545185
   with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
    bmax = 950.00
    hmax = 750.00
    From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
     bw = 450.00
    effective stress from (A.35), ff,e = 881.8461
   ----
    fy = 0.03444474
   Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
   af = 0.28545185
   with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
    bmax = 950.00
    hmax = 750.00
    From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
     bw = 450.00
    effective stress from (A.35), ff,e = 881.8461

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

The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max1 by a length
equal to half the clear spacing between external hoops.
AnoConf1 = 173066.667 is the unconfined external core area which is equal to   bi2/6 as defined at (A.2).
ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 110709.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 458.0986
fy1 = 381.7488
su1 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 381.7488
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.00143155
sh2 = 0.00458096
ft2 = 458.0986
fy2 = 381.7488
su2 = 0.00550601
   using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
     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 = 381.7488
     with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00143155
  shv = 0.00458096
 ftv = 452.7869
 fyv = 377.3224
  suv = 0.00550601
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.31005242
     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 = 377.3224
     with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.04363047
   2 = Asl,com/(b*d)*(fs2/fc) = 0.04363047
   v = Asl,mid/(b*d)*(fsv/fc) = 0.10121073
and confined core properties:
  b = 390.00
  d = 877.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.80412
   cc (5A.5, TBDY) = 0.00224367
      c = confinement factor = 1.02437
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.05206495
    2 = Asl,com/(b*d)*(fs2/fc) = 0.05206495
    v = Asl,mid/(b*d)*(fsv/fc) = 0.12077642
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.17751206
Mu = MRc (4.14) = 9.6965E+008
  u =   su (4.1) = 7.3807483E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
     = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)

```
      t = 1.00
      s = 0.80
      e = 1.00
    cb = 25.00
   Ktr = 1.37392
    Atr = Min(Atr_x,Atr_y) = 257.6106
    where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
    s = Max(s_external,s_internal) = 250.00
    n = 30.00
```


Calculation of Mu2-

Calculation of ultimate curvature ϕu according to 4.1, Biskinis/Fardis 2013:
  $\phi u = 7.3807483E-006$
Mu = 9.6965E+008
----
with full section properties:
  b = 450.00
  d = 907.00
  d' = 43.00
  v = 0.0015437
    N = 20792.011
  fc = 33.00
   εco (5A.5, TBDY) = 0.002
  Final value of εcu: $\varepsilon cu^* = shear\_factor * Max(\varepsilon cu, \varepsilon cc) = 0.01209008$
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: $\varepsilon cu = 0.01209008$
      ωwe ((5.4c), TBDY) = $ase^* \rho sh,min^* fywe/fce + Min(\omega fx, \omega fy) = 0.04611842$
    where $\omega f = af^* \rho f^* ffe/fce$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

      $\omega fx = 0.03444474$
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = $((bmax-2R)^2 + (hmax-2R)^2)/3 = 160566.667$
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), $\rho f = 2tf/bw = 0.00451556$
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

      $\omega fy = 0.03444474$
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = $((bmax-2R)^2 + (hmax-2R)^2)/3 = 160566.667$
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), $\rho f = 2tf/bw = 0.00451556$
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
      fu,f = 1055.00
      Ef = 64828.00
      $\varepsilon u,f = 0.015$
      ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
        ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and

                                                                                              69
```

is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max1 by a length
equal to half the clear spacing between external hoops.
AnoConf1 = 173066.667 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 110709.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
-----------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548
-----------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548
-----------------------------------------------------------------
Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 458.0986
fy1 = 381.7488
su1 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 381.7488
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 458.0986
fy2 = 381.7488
su2 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
    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 = 381.7488
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00143155
  shv = 0.00458096
 ftv = 452.7869
 fyv = 377.3224
  suv = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.31005242
    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 = 377.3224
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.04363047
  2 = Asl,com/(b*d)*(fs2/fc) = 0.04363047
  v = Asl,mid/(b*d)*(fsv/fc) = 0.10121073
and confined core properties:
  b = 390.00
  d = 877.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.80412
  cc (5A.5, TBDY) = 0.00224367
    c  = confinement factor = 1.02437
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.05206495
    2 = Asl,com/(b*d)*(fs2/fc) = 0.05206495
    v = Asl,mid/(b*d)*(fsv/fc) = 0.12077642
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.17751206
Mu = MRc (4.14) = 9.6965E+008
 u =  su (4.1) = 7.3807483E-006
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
    = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
    t = 1.00
    s = 0.80
    e = 1.00
  cb = 25.00
  Ktr = 1.37392
    Atr = Min(Atr_x,Atr_y) = 257.6106

where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 30.00

----------------------------------------------------------------------
----------------------------------------------------------------------
----------------------------------------------------------------------
----------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.6269E+006
----------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 1.6269E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 1.6269E+006
  knl = 1 (zero step-static loading)
------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
------------------------------------------------------------
   = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
    Mu = 0.62237178
    Vu = 4.4410684E-008
  d = 0.8*h = 760.00
  Nu = 20792.011
  Ag = 427500.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 1.0846E+006
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 977392.20
  Vs,j1 = 314161.779 is calculated for section web jacket, with:
    d = 360.00
    Av = 157079.633
    fy = 555.56
    s = 100.00
  Vs,j1 is multiplied by  Col,j1 = 1.00
    s/d = 0.27777778
  Vs,j2 = 663230.422 is calculated for section flange jacket, with:
    d = 760.00
    Av = 157079.633
    fy = 555.56
    s = 100.00
  Vs,j2 is multiplied by  Col,j2 = 1.00
    s/d = 0.13157895
 Vs,core = Vs,c1 + Vs,c2 = 107231.957
  Vs,c1 = 0.00 is calculated for section web core, with:
    d = 200.00
    Av = 100530.965
    fy = 444.44
    s = 250.00
  Vs,c1 is multiplied by  Col,c1 = 0.00
    s/d = 1.25
  Vs,c2 = 107231.957 is calculated for section flange core, with:
    d = 600.00
    Av = 100530.965
    fy = 444.44
    s = 250.00
  Vs,c2 is multiplied by  Col,c2 = 1.00
    s/d = 0.41666667
 Vf ((11-3)-(11.4), ACI 440) = 477918.239
    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) = 907.00

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 <= 1.1791E+006

  bw = 450.00

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

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

Calculation of Shear Strength at edge 2, Vr2 = 1.6269E+006

Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0

  VCol0 = 1.6269E+006

  knl = 1 (zero step-static loading)

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

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

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

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

    = 1 (normal-weight concrete)

  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)

  M/Vd = 2.00

    Mu = 0.62124232

    Vu = 4.4410684E-008

  d = 0.8*h = 760.00

  Nu = 20792.011

  Ag = 427500.00

  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 1.0846E+006

  where:

  Vs,jacket = Vs,j1 + Vs,j2 = 977392.20

  Vs,j1 = 314161.779 is calculated for section web jacket, with:

    d = 360.00

    Av = 157079.633

    fy = 555.56

    s = 100.00

  Vs,j1 is multiplied by Col,j1 = 1.00

    s/d = 0.27777778

  Vs,j2 = 663230.422 is calculated for section flange jacket, with:

    d = 760.00

    Av = 157079.633

    fy = 555.56

    s = 100.00

  Vs,j2 is multiplied by Col,j2 = 1.00

    s/d = 0.13157895

  Vs,core = Vs,c1 + Vs,c2 = 107231.957

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

    d = 200.00

    Av = 100530.965

    fy = 444.44

    s = 250.00

  Vs,c1 is multiplied by Col,c1 = 0.00

    s/d = 1.25

  Vs,c2 = 107231.957 is calculated for section flange core, with:

    d = 600.00

    Av = 100530.965

    fy = 444.44

    s = 250.00

  Vs,c2 is multiplied by Col,c2 = 1.00

    s/d = 0.41666667

  Vf ((11-3)-(11.4), ACI 440) = 477918.239

    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) = 907.00
  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 <= 1.1791E+006
    bw = 450.00
-------------------------------------------------------------
-------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1
At local axis: 2


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


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

Constant Properties
-------------------------------------------------------------
Knowledge Factor,    = 0.90
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lb = 300.00
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 = -2.4941E+007
Shear Force, V2 = -8272.465
Shear Force, V3 = -17.12416
Axial Force, F = -21341.949
Longitudinal Reinforcement Area Distribution (in 2 divisions)
    -Tension: Aslt = 0.00
  -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
    -Tension: Asl,ten = 1539.38
  -Compression: Asl,com = 1539.38
    -Middle: Asl,mid = 3612.832
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
    -Tension: Asl,ten,jacket = 1231.504
  -Compression: Asl,com,jacket = 1231.504
    -Middle: Asl,mid,jacket = 2689.203
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
    -Tension: Asl,ten,core = 307.8761
  -Compression: Asl,com,core = 307.8761
    -Middle: Asl,mid,core = 923.6282
Mean Diameter of Tension Reinforcement, DbL = 16.57143
-----------------------------------------------------------
-----------------------------------------------------------


Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $\theta$u,R = $\ast$ $\theta$u = 0.0026266
$\theta$u = $\theta$y + $\theta$p = 0.00291845


-----------------------------------------------------------
- Calculation of $\theta$y -
-----------------------------------------------------------
$\theta$y = (My*Ls/3)/EIeff = 0.00291845 ((4.29),Biskinis Phd))
 My = 7.6202E+008
 Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3014.959
 From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 2.6241E+014
   factor = 0.30
    Ag = 562500.00
    Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333
    N = 21341.949
   Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 8.7468E+014
-----------------------------------------------------------
-----------------------------------------------------------

Calculation of Yielding Moment My
-----------------------------------------------------------
Calculation of $\theta$y and My according to Annex 7 -
-----------------------------------------------------------
$\theta$y = Min($\theta$y_ten, $\theta$y_com)
$\theta$y_ten = 2.6145845E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 352.1657
   d = 907.00
    y = 0.25748191
   A = 0.01654341
   B = 0.00873458
    with pt = 0.0037716
      pc = 0.0037716
      pv = 0.00885172
      N = 21341.949
      b = 450.00
       " = 0.04740904
$\theta$y_comp = 9.5509837E-006
 with fc* (12.3, (ACI 440)) = 33.253
   fc = 33.00
   fl = 0.43533893
   b = bmax = 950.00
   h = hmax = 750.00
   Ag = 0.5625
    g = pt + pc + pv = 0.01639493

```
      rc = 40.00
      Ae/Ac = 0.29742395
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
    effective strain from (12.5) and (12.12), efe = 0.004
      fu = 0.01
    Ef = 64828.00
   Ec = 26999.444
     y = 0.25591344
    A = 0.016277
    B = 0.0085861
     with Es = 200000.00
------------------------------------------------------------
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Lap Length: ld/ld,min = 0.38756552
lb = 300.00
ld = 774.0627
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
     = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 524.4464
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
    t = 1.00
    s = 0.80
    e = 1.00
  cb = 25.00
  Ktr = 1.37392
   Atr = Min(Atr_x,Atr_y) = 257.6106
   where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
   s = Max(s_external,s_internal) = 250.00
   n = 30.00


------------------------------------------------------------
 - 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 = 0.39733369
   d = d_external = 907.00
   s = s_external = 0.00
 -   t =    s1 +    s2 + 2*tf/bw*(ffe/fs) = 0.00638555
   jacket:   s1 = Av1*Lstir1/(s1*Ag) = 0.00357443
        Av1 = 78.53982, is the area of every stirrup parallel to loading (shear) direction
        Lstir1 = 2560.00, is the total Length of all stirrups parallel to loading (shear) direction
        s1 = 100.00
   core:    s2 = Av2*Lstir2/(s2*Ag) = 0.00070345
        Av2 = 50.26548, is the area of every stirrup parallel to loading (shear) direction
        Lstir2 = 1968.00, is the total Length of all stirrups parallel to loading (shear) direction
        s2 = 250.00
   The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
   where   f = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises   f to steel strength
   All these variables have already been given in Shear control ratio calculation.
   For the normalisation fs of jacket is used.
    NUD = 21341.949
    Ag = 562500.00
    f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 26.93333
    fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein =
529.9972
    fytE = (fy_ext_Trans_Reinf*  s1+fy_int_Trans_Reinf*  s2)/(  s1+  s2) = 537.2876
pl = Area_Tot_Long_Rein/(b*d) = 0.01639493
   b = 450.00
   d = 907.00
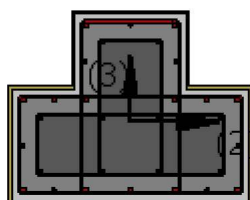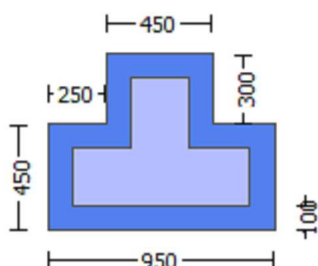    f'cE = 26.93333
```

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

Calculation No. 5

column C1, Floor 1

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

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (2)

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

Constant Properties

Knowledge Factor,   = 0.90
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 21019.039

Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of y for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.44
##
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = lb = 300.00
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 = -2.4941E+007
Shear Force, Va = -8272.465
EDGE -B-
Bending Moment, Mb = 118914.623
Shear Force, Vb = 8272.465
BOTH EDGES
Axial Force, F = -21341.949
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
      -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1539.38
      -Compression: Asl,com = 1539.38
        -Middle: Asl,mid = 3612.832
Mean Diameter of Tension Reinforcement, DbL,ten = 16.57143

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR =   *Vn = 1.2873E+006
Vn ((10.3), ASCE 41-17) = knl*VColO = 1.4303E+006
   VCol = 1.4303E+006
   knl = 1.00
      displacement_ductility_demand = 0.04953751

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 = 20.80, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 118914.623
Vu = 8272.465
d = 0.8*h = 760.00
Nu = 21341.949
Ag = 427500.00
From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 976155.669
where:
Vs,jacket = Vs,j1 + Vs,j2 = 879645.943
Vs,j1 = 282743.339 is calculated for section web jacket, with:
   d = 360.00
   Av = 157079.633
   fy = 500.00
   s = 100.00
Vs,j1 is multiplied by Col,j1 = 1.00
   s/d = 0.27777778
Vs,j2 = 596902.604 is calculated for section flange jacket, with:
   d = 760.00
   Av = 157079.633
   fy = 500.00
   s = 100.00
Vs,j2 is multiplied by Col,j2 = 1.00
   s/d = 0.13157895
Vs,core = Vs,c1 + Vs,c2 = 96509.726
Vs,c1 = 0.00 is calculated for section web core, with:
   d = 200.00
   Av = 100530.965
   fy = 400.00
   s = 250.00
Vs,c1 is multiplied by Col,c1 = 0.00
   s/d = 1.25
Vs,c2 = 96509.726 is calculated for section flange core, with:
   d = 600.00
   Av = 100530.965
   fy = 400.00
   s = 250.00
Vs,c2 is multiplied by Col,c2 = 1.00
   s/d = 0.41666667
Vf ((11-3)-(11.4), ACI 440) = 477918.239
   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) = 907.00
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 <= 1.0362E+006
   bw = 450.00

----
displacement_ductility_demand is calculated as μ / μy

 - Calculation of μ / μy for END B -

for rotation axis 3 and integ. section (b)

From analysis, chord rotation   = 1.4385520E-005
 y = (My*Ls/3)/Eleff = 0.0002904 ((4.29),Biskinis Phd))
  My = 7.6202E+008
  Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 300.00
  From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 2.6241E+014
     factor = 0.30
        Ag = 562500.00
        Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333
        N = 21341.949
     Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 8.7468E+014

Calculation of Yielding Moment My

Calculation of   y and My according to Annex 7   -
----
 y = Min(y_ten, y_com)
 y_ten = 2.6145845E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 352.1657
    d = 907.00
     y = 0.25748191
    A = 0.01654341
    B = 0.00873458
     with pt = 0.0037716
        pc = 0.0037716
        pv = 0.00885172
        N = 21341.949
        b = 450.00
        " = 0.04740904
 y_comp = 9.5509837E-006
 with fc* (12.3, (ACI 440)) = 33.253
    fc = 33.00
    fl = 0.43533893
    b = bmax = 950.00
    h = hmax = 750.00
    Ag = 0.5625
       g = pt + pc + pv = 0.01639493
    rc = 40.00
    Ae/Ac = 0.29742395
    Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
   effective strain from (12.5) and (12.12), efe = 0.004
     fu = 0.01
   Ef = 64828.00
   Ec = 26999.444
    y = 0.25591344
   A = 0.016277
   B = 0.0085861
    with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.38756552
lb = 300.00
ld = 774.0627
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
    = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 524.4464
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
    t = 1.00
    s = 0.80

e = 1.00
cb = 25.00
Ktr = 1.37392
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 30.00

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

Constant Properties

Knowledge Factor,   = 0.90
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column

Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 555.55
##
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.02437
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
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 = -0.00053663
EDGE -B-
Shear Force, Vb = 0.00053663
BOTH EDGES
Axial Force, F = -20792.011
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1539.38
     -Compression: Asl,com = 2475.575
        -Middle: Asl,mid = 2676.637

Calculation of Shear Capacity ratio , Ve/Vr = 0.56344875
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 624335.951
with
Mpr1 = Max(Mu1+ , Mu1-) = 9.3650E+008
   Mu1+ = 6.7320E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination

Mu1- = 9.3650E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination

Mpr2 = Max(Mu2+ , Mu2-) = 9.3650E+008

Mu2+ = 6.7320E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination

Mu2- = 9.3650E+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 = 9.1136953E-006
Mu = 6.7320E+008
----
with full section properties:
  b = 950.00
  d = 707.00
  d' = 43.00
  v = 0.00093808
     N = 20792.011
  fc = 33.00
   ϵco (5A.5, TBDY) = 0.002
  Final value of ϵcu: $\epsilon cu*$ = shear_factor * Max(ϵcu, ϵcc) = 0.01209008
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: ϵcu = 0.01209008
       ωwe ((5.4c), TBDY) = $\alpha se*$ $\rho sh,min*fywe/fce$+Min(ωfx, ωfy) = 0.04611842
     where $\omega f = \alpha f*\rho f*ffe/fce$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

       ωfx = 0.03444474
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
       bmax = 950.00
       hmax = 750.00
       From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
         bw = 450.00
       effective stress from (A.35), ff,e = 881.8461

       ωfy = 0.03444474
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
       bmax = 950.00
       hmax = 750.00
       From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
         bw = 450.00
       effective stress from (A.35), ff,e = 881.8461

       R = 40.00
       Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
       fu,f = 1055.00
       Ef = 64828.00
        $\epsilon u,f$ = 0.015
       αse ((5.4d), TBDY) = ($\alpha se1*Aext+\alpha se2*Aint$)/Asec = 0.53375773
         ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
         The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
         of the rectangular sections confinement, which is expressed by (5.4d).
         The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
         "Theoretical Stress-Strain Model for Confined Concrete."
         J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
         Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
                 is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
         Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
                 is calculated by reducing all the dimensions of the area Aconf,max1 by a length

equal to half the clear spacing between external hoops.

AnoConf1 = 173066.667 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).

ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773

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

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

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

"Theoretical Stress-Strain Model for Confined Concrete."

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

Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and

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

Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and

is calculated by reducing all the dimensions of the area Aconf,max2 by a length

equal to half the clear spacing between internal hoops.

AnoConf2 = 110709.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).

psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578

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

----

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578

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

Lstir1 (Length of stirrups along Y) = 2160.00

Astir1 (stirrups area) = 78.53982

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

Lstir2 (Length of stirrups along Y) = 1568.00

Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307

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

Lstir1 (Length of stirrups along X) = 2560.00

Astir1 (stirrups area) = 78.53982

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

Lstir2 (Length of stirrups along X) = 1968.00

Astir2 (stirrups area) = 50.26548

Asec = 562500.00

s1 = 100.00

s2 = 250.00

fywe1 = 694.45

fywe2 = 555.55

fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00224367

c = confinement factor = 1.02437

y1 = 0.00143155

sh1 = 0.00458096

ft1 = 458.0986

fy1 = 381.7488

su1 = 0.00550601

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

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/ld = 0.31005242

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 = 381.7488

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

y2 = 0.00143155

sh2 = 0.00458096

ft2 = 453.4475

fy2 = 377.8729

su2 = 0.00550601

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242

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 = 377.8729
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00143155
shv = 0.00458096
ftv = 455.2307
fyv = 379.359
suv = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 379.359
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.02651348
2 = Asl,com/(b*d)*(fs2/fc) = 0.04220509
v = Asl,mid/(b*d)*(fsv/fc) = 0.04581238
and confined core properties:
b = 890.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 33.80412
cc (5A.5, TBDY) = 0.00224367
c = confinement factor = 1.02437
1 = Asl,ten/(b*d)*(fs1/fc) = 0.029555
2 = Asl,com/(b*d)*(fs2/fc) = 0.0470467
v = Asl,mid/(b*d)*(fsv/fc) = 0.0510678
Case/Assumption: Unconfinesd full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.14547789
Mu = MRc (4.14) = 6.7320E+008
u =   su (4.1) = 9.1136953E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 16.66667
Mean strength value of all re-bars: fy = 655.558
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
t = 1.00
s = 0.80
e = 1.00
cb = 25.00
Ktr = 1.37392
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 30.00

Calculation of Mu1-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
  u = 9.8526632E-006
Mu = 9.3650E+008
----
with full section properties:
  b = 450.00
  d = 707.00
  d' = 43.00
  v = 0.00198039
   N = 20792.011
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01209008
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.01209008
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+ Min(fx, fy) = 0.04611842
    where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----
      fx = 0.03444474
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+ (hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461
    ----
      fy = 0.03444474
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+ (hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

      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 = 0.53375773
      ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
      The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
      of the rectangular sections confinement, which is expressed by (5.4d).
      The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
      "Theoretical Stress-Strain Model for Confined Concrete."
      J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
      Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
         is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
      Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
         is calculated by reducing all the dimensions of the area Aconf,max1 by a length
         equal to half the clear spacing between external hoops.
      AnoConf1 = 173066.667 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
    ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
      The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
      of the rectangular sections confinement, which is expressed by (5.4d).
      The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)

"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 110709.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548

----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 453.4475
fy1 = 377.8729
su1 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 377.8729
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 458.0986
fy2 = 381.7488
su2 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
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 = 381.7488

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00143155
shv = 0.00458096
ftv = 455.2307
fyv = 379.359
suv = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 379.359
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.08909964
2 = Asl,com/(b*d)*(fs2/fc) = 0.05597289
v = Asl,mid/(b*d)*(fsv/fc) = 0.09671502
and confined core properties:
b = 390.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 33.80412
cc (5A.5, TBDY) = 0.00224367
c = confinement factor = 1.02437
1 = Asl,ten/(b*d)*(fs1/fc) = 0.10736299
2 = Asl,com/(b*d)*(fs2/fc) = 0.06744603
v = Asl,mid/(b*d)*(fsv/fc) = 0.11653935
Case/Assumption: Unconfinesd full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.20956863
Mu = MRc (4.14) = 9.3650E+008
u =   su (4.1) = 9.8526632E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 16.66667
Mean strength value of all re-bars: fy = 655.558
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
t = 1.00
s = 0.80
e = 1.00
cb = 25.00
Ktr = 1.37392
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 30.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 9.1136953E-006
Mu = 6.7320E+008
----
with full section properties:
  b = 950.00
  d = 707.00
  d' = 43.00
  ν = 0.00093808
   N = 20792.011
  fc = 33.00
   εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.01209008
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.01209008
     ωwe ((5.4c), TBDY) = αse*ρsh,min*fywe/fce+Min(ρfx, ρfy) = 0.04611842
    where ρf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

     ρfx = 0.03444474
    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
    αf = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
     bmax = 950.00
     hmax = 750.00
     From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00451556
      bw = 450.00
     effective stress from (A.35), ff,e = 881.8461

     ρfy = 0.03444474
    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
    αf = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
     bmax = 950.00
     hmax = 750.00
     From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00451556
      bw = 450.00
     effective stress from (A.35), ff,e = 881.8461

    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 = 0.53375773
     αse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
     The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
     of the rectangular sections confinement, which is expressed by (5.4d).
     The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
     "Theoretical Stress-Strain Model for Confined Concrete."
     J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
     Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
       is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
     Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
       is calculated by reducing all the dimensions of the area Aconf,max1 by a length
        equal to half the clear spacing between external hoops.
     AnoConf1 = 173066.667 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
    αse2 (>=αse1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
     The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
     of the rectangular sections confinement, which is expressed by (5.4d).
     The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
     "Theoretical Stress-Strain Model for Confined Concrete."
     J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
     Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
       is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
     Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
       is calculated by reducing all the dimensions of the area Aconf,max2 by a length

equal to half the clear spacing between internal hoops.

AnoConf2 = 110709.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).

psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578

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

----

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578

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

   Lstir1 (Length of stirrups along Y) = 2160.00

   Astir1 (stirrups area) = 78.53982

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

   Lstir2 (Length of stirrups along Y) = 1568.00

   Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307

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

   Lstir1 (Length of stirrups along X) = 2560.00

   Astir1 (stirrups area) = 78.53982

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

   Lstir2 (Length of stirrups along X) = 1968.00

   Astir2 (stirrups area) = 50.26548

Asec = 562500.00

s1 = 100.00

s2 = 250.00

fywe1 = 694.45

fywe2 = 555.55

fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00224367

   c = confinement factor = 1.02437

y1 = 0.00143155

sh1 = 0.00458096

ft1 = 458.0986

fy1 = 381.7488

su1 = 0.00550601

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

   and also multiplied by the shear_factor according to 15.7.1.4, with

   Shear_factor = 1.00

   lo/lou,min = lb/ld = 0.31005242

   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 = 381.7488

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

y2 = 0.00143155

sh2 = 0.00458096

ft2 = 453.4475

fy2 = 377.8729

su2 = 0.00550601

   using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242

   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 = 377.8729

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

yv = 0.00143155

shv = 0.00458096

ftv = 455.2307

fyv = 379.359

suv = 0.00550601

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
  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 = 379.359
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.02651348
 2 = Asl,com/(b*d)*(fs2/fc) = 0.04220509
 v = Asl,mid/(b*d)*(fsv/fc) = 0.04581238
and confined core properties:
 b = 890.00
 d = 677.00
 d' = 13.00
 fcc (5A.2, TBDY) = 33.80412
  cc (5A.5, TBDY) = 0.00224367
    c = confinement factor = 1.02437
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.029555
  2 = Asl,com/(b*d)*(fs2/fc) = 0.0470467
  v = Asl,mid/(b*d)*(fsv/fc) = 0.0510678
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.14547789
Mu = MRc (4.14) = 6.7320E+008
 u =   su (4.1) = 9.1136953E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
    = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
    t = 1.00
    s = 0.80
    e = 1.00
  cb = 25.00
  Ktr = 1.37392
   Atr = Min(Atr_x,Atr_y) = 257.6106
   where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
   s = Max(s_external,s_internal) = 250.00
   n = 30.00

Calculation of Mu2-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 u = 9.8526632E-006
Mu = 9.3650E+008
----
with full section properties:

b = 450.00
d = 707.00
d' = 43.00
v = 0.00198039
  N = 20792.011
fc = 33.00
 co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01209008
   The Shear_factor is considered equal to 1 (pure moment strength)
   From (5.4b), TBDY: cu = 0.01209008
    we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.04611842
   where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
   ----
    fx = 0.03444474
   Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
   af = 0.28545185
   with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
    bmax = 950.00
    hmax = 750.00
    From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
     bw = 450.00
    effective stress from (A.35), ff,e = 881.8461
   ----
    fy = 0.03444474
   Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
   af = 0.28545185
   with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
    bmax = 950.00
    hmax = 750.00
    From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
     bw = 450.00
    effective stress from (A.35), ff,e = 881.8461

    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 = 0.53375773
     ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
     The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
     of the rectangular sections confinement, which is expressed by (5.4d).
     The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
     "Theoretical Stress-Strain Model for Confined Concrete."
     J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
     Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
       is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
     Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
       is calculated by reducing all the dimensions of the area Aconf,max1 by a length
       equal to half the clear spacing between external hoops.
    AnoConf1 = 173066.667 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
    ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
     The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
     of the rectangular sections confinement, which is expressed by (5.4d).
     The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
     "Theoretical Stress-Strain Model for Confined Concrete."
     J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
     Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
       is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
     Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
       is calculated by reducing all the dimensions of the area Aconf,max2 by a length
       equal to half the clear spacing between internal hoops.
    AnoConf2 = 110709.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
    psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
   Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

```
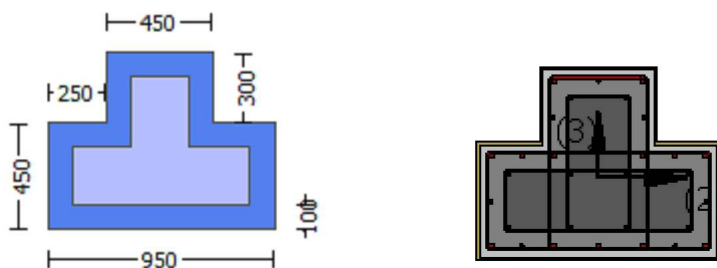        psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
           Lstir1 (Length of stirrups along Y) = 2160.00
           Astir1 (stirrups area) = 78.53982
        psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
           Lstir2 (Length of stirrups along Y) = 1568.00
           Astir2 (stirrups area) = 50.26548
     --------------------------------------------------------------------
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
           Lstir1 (Length of stirrups along X) = 2560.00
           Astir1 (stirrups area) = 78.53982
        psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
           Lstir2 (Length of stirrups along X) = 1968.00
           Astir2 (stirrups area) = 50.26548
     --------------------------------------------------------------------
           Asec = 562500.00
           s1 = 100.00
           s2 = 250.00
        fywe1 = 694.45
        fywe2 = 555.55
        fce  = 33.00
     From ((5.A5), TBDY), TBDY:  cc = 0.00224367
           c  = confinement factor = 1.02437
   y1 = 0.00143155
  sh1 = 0.00458096
 ft1 = 453.4475
 fy1 = 377.8729
  su1 = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.31005242
     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 = 377.8729
      with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
   y2 = 0.00143155
  sh2 = 0.00458096
 ft2 = 458.0986
 fy2 = 381.7488
  su2 = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
     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 = 381.7488
      with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
   yv = 0.00143155
  shv = 0.00458096
 ftv = 455.2307
 fyv = 379.359
  suv = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.31005242
     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 = 379.359
   with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.08909964
  2 = Asl,com/(b*d)*(fs2/fc) = 0.05597289
  v = Asl,mid/(b*d)*(fsv/fc) = 0.09671502
and confined core properties:
  b = 390.00
  d = 677.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.80412
   cc (5A.5, TBDY) = 0.00224367
      c = confinement factor = 1.02437
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.10736299
   2 = Asl,com/(b*d)*(fs2/fc) = 0.06744603
   v = Asl,mid/(b*d)*(fsv/fc) = 0.11653935
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.20956863
Mu = MRc (4.14) = 9.3650E+008
 u =   su (4.1) = 9.8526632E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
    = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
   t = 1.00
   s = 0.80
   e = 1.00
  cb = 25.00
  Ktr = 1.37392
   Atr = Min(Atr_x,Atr_y) = 257.6106
   where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
   s = Max(s_external,s_internal) = 250.00
   n = 30.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.1081E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.1081E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 1.1081E+006
  knl = 1 (zero step-static loading)

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

    = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00

Mu = 761.1315
Vu = 0.00053663
d = 0.8*h = 600.00
Nu = 20792.011
Ag = 337500.00
From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 916401.511
where:
Vs,jacket = Vs,j1 + Vs,j2 = 837764.743
Vs,j1 = 523602.964 is calculated for section web jacket, with:
d = 600.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs,j1 is multiplied by   Col,j1 = 1.00
s/d = 0.16666667
Vs,j2 = 314161.779 is calculated for section flange jacket, with:
d = 360.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs,j2 is multiplied by   Col,j2 = 1.00
s/d = 0.27777778
Vs,core = Vs,c1 + Vs,c2 = 78636.768
Vs,c1 = 78636.768 is calculated for section web core, with:
d = 440.00
Av = 100530.965
fy = 444.44
s = 250.00
Vs,c1 is multiplied by   Col,c1 = 1.00
s/d = 0.56818182
Vs,c2 = 0.00 is calculated for section flange core, with:
d = 200.00
Av = 100530.965
fy = 444.44
s = 250.00
Vs,c2 is multiplied by   Col,c2 = 0.00
s/d = 1.25
Vf ((11-3)-(11.4), ACI 440) = 372533.843
  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) = 707.00
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 < = 930841.148
  bw = 450.00

Calculation of Shear Strength at edge 2, Vr2 = 1.1081E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 1.1081E+006
knl = 1 (zero step-static loading)

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

  = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 < =
8.3 MPa (22.5.3.1, ACI 318-14)

M/Vd = 4.00
   Mu = 761.1315
   Vu = 0.00053663
d = 0.8*h = 600.00
Nu = 20792.011
Ag = 337500.00
From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 916401.511
  where:
Vs,jacket = Vs,j1 + Vs,j2 = 837764.743
Vs,j1 = 523602.964 is calculated for section web jacket, with:
   d = 600.00
   Av = 157079.633
   fy = 555.56
   s = 100.00
Vs,j1 is multiplied by Col,j1 = 1.00
   s/d = 0.16666667
Vs,j2 = 314161.779 is calculated for section flange jacket, with:
   d = 360.00
   Av = 157079.633
   fy = 555.56
   s = 100.00
Vs,j2 is multiplied by Col,j2 = 1.00
   s/d = 0.27777778
Vs,core = Vs,c1 + Vs,c2 = 78636.768
Vs,c1 = 78636.768 is calculated for section web core, with:
   d = 440.00
   Av = 100530.965
   fy = 444.44
   s = 250.00
Vs,c1 is multiplied by Col,c1 = 1.00
   s/d = 0.56818182
Vs,c2 = 0.00 is calculated for section flange core, with:
   d = 200.00
   Av = 100530.965
   fy = 444.44
   s = 250.00
Vs,c2 is multiplied by Col,c2 = 0.00
   s/d = 1.25
Vf ((11-3)-(11.4), ACI 440) = 372533.843
  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) = 707.00
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 <= 930841.148
  bw = 450.00

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

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

Constant Properties

Knowledge Factor,   = 0.90
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 555.55
##
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.02437
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
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 = -4.4410684E-008
EDGE -B-
Shear Force, Vb = 4.4410684E-008
BOTH EDGES
Axial Force, F = -20792.011
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1539.38
     -Compression: Asl,com = 1539.38

-Middle: Asl,mid = 3612.832

Calculation of Shear Capacity ratio , Ve/Vr = 0.39733369
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 646432.814
with
Mpr1 = Max(Mu1+ , Mu1-) = 9.6965E+008
   Mu1+ = 9.6965E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
   Mu1- = 9.6965E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 9.6965E+008
   Mu2+ = 9.6965E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
   Mu2- = 9.6965E+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 = 7.3807483E-006
Mu = 9.6965E+008
----
with full section properties:
  b = 450.00
  d = 907.00
  d' = 43.00
  v = 0.0015437
     N = 20792.011
  fc = 33.00
   ϵco (5A.5, TBDY) = 0.002
  Final value of ϵcu: ϵcu^* = shear_factor * Max(ϵcu, ϵcc) = 0.01209008
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: ϵcu = 0.01209008
       ωwe ((5.4c), TBDY) = αse^* $\rho sh,min^*fywe/fce + Min(\omega fx, \omega fy)$ = 0.04611842
     where $\omega f = \alpha f^*\rho f^*ffe/fce$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

       ωfx = 0.03444474
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
        bmax = 950.00
        hmax = 750.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
          bw = 450.00
        effective stress from (A.35), ff,e = 881.8461

       ωfy = 0.03444474
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
        bmax = 950.00
        hmax = 750.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
          bw = 450.00
        effective stress from (A.35), ff,e = 881.8461

       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 = 0.53375773
   ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
   The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
   of the rectangular sections confinement, which is expressed by (5.4d).
   The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
   "Theoretical Stress-Strain Model for Confined Concrete."
   J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
   Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
      is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
   Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
      is calculated by reducing all the dimensions of the area Aconf,max1 by a length
      equal to half the clear spacing between external hoops.
   AnoConf1 = 173066.667 is the unconfined external core area which is equal to   bi2/6 as defined at (A.2).
ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
   The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
   of the rectangular sections confinement, which is expressed by (5.4d).
   The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
   "Theoretical Stress-Strain Model for Confined Concrete."
   J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
   Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
      is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
   Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
      is calculated by reducing all the dimensions of the area Aconf,max2 by a length
      equal to half the clear spacing between internal hoops.
   AnoConf2 = 110709.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
----
   psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
   psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
      Lstir1 (Length of stirrups along Y) = 2160.00
      Astir1 (stirrups area) = 78.53982
   psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
      Lstir2 (Length of stirrups along Y) = 1568.00
      Astir2 (stirrups area) = 50.26548
----
   psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
   psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
      Lstir1 (Length of stirrups along X) = 2560.00
      Astir1 (stirrups area) = 78.53982
   psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
      Lstir2 (Length of stirrups along X) = 1968.00
      Astir2 (stirrups area) = 50.26548

   Asec = 562500.00
   s1 = 100.00
   s2 = 250.00
  fywe1 = 694.45
  fywe2 = 555.55
  fce = 33.00
From ((5.A5), TBDY): cc = 0.00224367
   c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 458.0986
fy1 = 381.7488
su1 = 0.00550601
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.31005242
  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 = 381.7488
  with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 458.0986
fy2 = 381.7488
su2 = 0.00550601
  using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
  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 = 381.7488
  with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00143155
shv = 0.00458096
ftv = 452.7869
fyv = 377.3224
suv = 0.00550601
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.31005242
  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 = 377.3224
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04363047
2 = Asl,com/(b*d)*(fs2/fc) = 0.04363047
v = Asl,mid/(b*d)*(fsv/fc) = 0.10121073
and confined core properties:
b = 390.00
d = 877.00
d' = 13.00
fcc (5A.2, TBDY) = 33.80412
cc (5A.5, TBDY) = 0.00224367
  c = confinement factor = 1.02437
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05206495
2 = Asl,com/(b*d)*(fs2/fc) = 0.05206495
v = Asl,mid/(b*d)*(fsv/fc) = 0.12077642
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.17751206
Mu = MRc (4.14) = 9.6965E+008
u = su (4.1) = 7.3807483E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
  = 1
db = 16.66667

Mean strength value of all re-bars: fy = 655.558
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  t = 1.00
  s = 0.80
  e = 1.00
cb = 25.00
Ktr = 1.37392
 Atr = Min(Atr_x,Atr_y) = 257.6106
 where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
 s = Max(s_external,s_internal) = 250.00
 n = 30.00

Calculation of Mu1-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 u = 7.3807483E-006
Mu = 9.6965E+008
----
with full section properties:
 b = 450.00
 d = 907.00
 d' = 43.00
 v = 0.0015437
  N = 20792.011
 fc = 33.00
  co (5A.5, TBDY) = 0.002
 Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01209008
  The Shear_factor is considered equal to 1 (pure moment strength)
  From (5.4b), TBDY: cu = 0.01209008
   we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.04611842
  where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
  ----
   fx = 0.03444474
  Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
  af = 0.28545185
  with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
   bmax = 950.00
   hmax = 750.00
   From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
    bw = 450.00
   effective stress from (A.35), ff,e = 881.8461
  ----
   fy = 0.03444474
  Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
  af = 0.28545185
  with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
   bmax = 950.00
   hmax = 750.00
   From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
    bw = 450.00
   effective stress from (A.35), ff,e = 881.8461

   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 = 0.53375773
    ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
    The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
    of the rectangular sections confinement, which is expressed by (5.4d).
    The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)

"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max1 by a length
equal to half the clear spacing between external hoops.
AnoConf1 = 173066.667 is the unconfined external core area which is equal to   bi2/6 as defined at (A.2).
ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 110709.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548

----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 458.0986
fy1 = 381.7488
su1 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 381.7488
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 458.0986

fy2 = 381.7488
  su2 = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
     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 = 381.7488
     with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00143155
  shv = 0.00458096
 ftv = 452.7869
 fyv = 377.3224
  suv = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.31005242
     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 = 377.3224
     with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.04363047
  2 = Asl,com/(b*d)*(fs2/fc) = 0.04363047
  v = Asl,mid/(b*d)*(fsv/fc) = 0.10121073
and confined core properties:
  b = 390.00
  d = 877.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.80412
  cc (5A.5, TBDY) = 0.00224367
    c = confinement factor = 1.02437
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.05206495
  2 = Asl,com/(b*d)*(fs2/fc) = 0.05206495
  v = Asl,mid/(b*d)*(fsv/fc) = 0.12077642
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.17751206
Mu = MRc (4.14) = 9.6965E+008
  u =   su (4.1) = 7.3807483E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
   = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
    t = 1.00
    s = 0.80
    e = 1.00

```
  cb = 25.00
  Ktr = 1.37392
   Atr = Min(Atr_x,Atr_y) = 257.6106
   where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
   s = Max(s_external,s_internal) = 250.00
   n = 30.00
-------------------------------------------------------------------------
-------------------------------------------------------------------------
-------------------------------------------------------------------------
Calculation of Mu2+
-------------------------------------------------------------------------


-------------------------------------------------------------------------
Calculation of ultimate curvature  u according to 4.1, Biskinis/Fardis 2013:
  u = 7.3807483E-006
Mu = 9.6965E+008
-------------------------------------------------------------------------
with full section properties:
  b = 450.00
  d = 907.00
  d' = 43.00
  v = 0.0015437
    N = 20792.011
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of  cu:  cu* = shear_factor * Max( cu, cc) = 0.01209008
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY:  cu = 0.01209008
       we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min( fx,  fy) = 0.04611842
     where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
     -----------------------------------------------------------------
       fx = 0.03444474
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
       bmax = 950.00
       hmax = 750.00
       From EC8 A4.4.3(6), pf = 2tf/bw = 0.00451556
          bw = 450.00
       effective stress from (A.35), ff,e = 881.8461
     -----------------------------------------------------------------
       fy = 0.03444474
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
       bmax = 950.00
       hmax = 750.00
       From EC8 A4.4.3(6), pf = 2tf/bw = 0.00451556
          bw = 450.00
       effective stress from (A.35), ff,e = 881.8461
     -----------------------------------------------------------------
       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 = 0.53375773
          ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
          The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
          of the rectangular sections confinement, which is expressed by (5.4d).
          The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
          "Theoretical Stress-Strain Model for Confined Concrete."
          J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
          Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
                  is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
          Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
                  is calculated by reducing all the dimensions of the area Aconf,max1 by a length
```

equal to half the clear spacing between external hoops.

AnoConf1 = 173066.667 is the unconfined external core area which is equal to   bi2/6 as defined at (A.2).

ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773

The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.

Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.

Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.

AnoConf2 = 110709.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).

psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578

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

----

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 458.0986
fy1 = 381.7488
su1 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 381.7488
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 458.0986
fy2 = 381.7488
su2 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242

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 = 381.7488
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00143155
  shv = 0.00458096
 ftv = 452.7869
 fyv = 377.3224
  suv = 0.00550601
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.31005242
    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 = 377.3224
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.04363047
   2 = Asl,com/(b*d)*(fs2/fc) = 0.04363047
   v = Asl,mid/(b*d)*(fsv/fc) = 0.10121073
and confined core properties:
  b = 390.00
  d = 877.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.80412
   cc (5A.5, TBDY) = 0.00224367
     c = confinement factor = 1.02437
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.05206495
    2 = Asl,com/(b*d)*(fs2/fc) = 0.05206495
    v = Asl,mid/(b*d)*(fsv/fc) = 0.12077642
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.17751206
Mu = MRc (4.14) = 9.6965E+008
 u = su (4.1) = 7.3807483E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
    = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
    t = 1.00
    s = 0.80
    e = 1.00
  cb = 25.00
  Ktr = 1.37392
   Atr = Min(Atr_x,Atr_y) = 257.6106
   where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
   s = Max(s_external,s_internal) = 250.00
   n = 30.00

Calculation of Mu2-

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

φu = 7.3807483E-006

Mu = 9.6965E+008

----

with full section properties:

b = 450.00

d = 907.00

d' = 43.00

v = 0.0015437

N = 20792.011

fc = 33.00

εco (5A.5, TBDY) = 0.002

Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.01209008

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

From (5.4b), TBDY: εcu = 0.01209008

ωwe ((5.4c), TBDY) = αse*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.04611842

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

ωfx = 0.03444474

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

αf = 0.28545185

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

bmax = 950.00

hmax = 750.00

From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00451556

bw = 450.00

effective stress from (A.35), ff,e = 881.8461

ωfy = 0.03444474

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

αf = 0.28545185

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

bmax = 950.00

hmax = 750.00

From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00451556

bw = 450.00

effective stress from (A.35), ff,e = 881.8461

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 = 0.53375773

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

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

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

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

"Theoretical Stress-Strain Model for Confined Concrete."

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

Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and

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

Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and

is calculated by reducing all the dimensions of the area Aconf,max1 by a length

equal to half the clear spacing between external hoops.

AnoConf1 = 173066.667 is the unconfined external core area which is equal to Σbi2/6 as defined at (A.2).

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

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

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

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

"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 110709.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

        ----
        psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
            Lstir1 (Length of stirrups along Y) = 2160.00
            Astir1 (stirrups area) = 78.53982
        psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
            Lstir2 (Length of stirrups along Y) = 1568.00
            Astir2 (stirrups area) = 50.26548

        ----
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
            Lstir1 (Length of stirrups along X) = 2560.00
            Astir1 (stirrups area) = 78.53982
        psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
            Lstir2 (Length of stirrups along X) = 1968.00
            Astir2 (stirrups area) = 50.26548

        Asec = 562500.00
        s1 = 100.00
        s2 = 250.00
        fywe1 = 694.45
        fywe2 = 555.55
        fce = 33.00
    From ((5.A5), TBDY), TBDY: cc = 0.00224367
        c = confinement factor = 1.02437
  y1 = 0.00143155
  sh1 = 0.00458096
 ft1 = 458.0986
fy1 = 381.7488
 su1 = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.31005242
     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 = 381.7488
     with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.00143155
  sh2 = 0.00458096
 ft2 = 458.0986
fy2 = 381.7488
 su2 = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
     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 = 381.7488

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00143155
  shv = 0.00458096
 ftv = 452.7869
 fyv = 377.3224
  suv = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.31005242
     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 = 377.3224
     with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.04363047
   2 = Asl,com/(b*d)*(fs2/fc) = 0.04363047
   v = Asl,mid/(b*d)*(fsv/fc) = 0.10121073
and confined core properties:
  b = 390.00
  d = 877.00
  d' = 13.00
 fcc (5A.2, TBDY) = 33.80412
   cc (5A.5, TBDY) = 0.00224367
     c = confinement factor = 1.02437
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.05206495
   2 = Asl,com/(b*d)*(fs2/fc) = 0.05206495
   v = Asl,mid/(b*d)*(fsv/fc) = 0.12077642
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.17751206
Mu = MRc (4.14) = 9.6965E+008
 u =   su (4.1) = 7.3807483E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
    = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
    t = 1.00
    s = 0.80
    e = 1.00
  cb = 25.00
  Ktr = 1.37392
   Atr = Min(Atr_x,Atr_y) = 257.6106
   where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
   s = Max(s_external,s_internal) = 250.00
   n = 30.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.6269E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.6269E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 1.6269E+006
  knl = 1 (zero step-static loading)

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

    λ = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
     Mu = 0.62237178
     Vu = 4.4410684E-008
  d = 0.8*h = 760.00
  Nu = 20792.011
  Ag = 427500.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 1.0846E+006
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 977392.20
  Vs,j1 = 314161.779 is calculated for section web jacket, with:
     d = 360.00
     Av = 157079.633
     fy = 555.56
     s = 100.00
  Vs,j1 is multiplied by Col,j1 = 1.00
     s/d = 0.27777778
  Vs,j2 = 663230.422 is calculated for section flange jacket, with:
     d = 760.00
     Av = 157079.633
     fy = 555.56
     s = 100.00
  Vs,j2 is multiplied by Col,j2 = 1.00
     s/d = 0.13157895
  Vs,core = Vs,c1 + Vs,c2 = 107231.957
  Vs,c1 = 0.00 is calculated for section web core, with:
     d = 200.00
     Av = 100530.965
     fy = 444.44
     s = 250.00
  Vs,c1 is multiplied by Col,c1 = 0.00
     s/d = 1.25
  Vs,c2 = 107231.957 is calculated for section flange core, with:
     d = 600.00
     Av = 100530.965
     fy = 444.44
     s = 250.00
  Vs,c2 is multiplied by Col,c2 = 1.00
     s/d = 0.41666667
  Vf ((11-3)-(11.4), ACI 440) = 477918.239
     ϕ_f = 0.95, for fully-wrapped sections
  wf/sf = 1 (FRP strips adjacent to one another).
  In (11.3) sin α + cos α is replaced with (cot θ+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) = 907.00
  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 <= 1.1791E+006
     bw = 450.00

```
--------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 1.6269E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 1.6269E+006
  knl = 1 (zero step-static loading)
------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+  f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
------------------------------------------------------------
    = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
    Mu = 0.62124232
    Vu = 4.4410684E-008
  d = 0.8*h = 760.00
  Nu = 20792.011
  Ag = 427500.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 1.0846E+006
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 977392.20
  Vs,j1 = 314161.779 is calculated for section web jacket, with:
    d = 360.00
    Av = 157079.633
    fy = 555.56
    s = 100.00
  Vs,j1 is multiplied by   Col,j1 = 1.00
    s/d = 0.27777778
  Vs,j2 = 663230.422 is calculated for section flange jacket, with:
    d = 760.00
    Av = 157079.633
    fy = 555.56
    s = 100.00
  Vs,j2 is multiplied by   Col,j2 = 1.00
    s/d = 0.13157895
  Vs,core = Vs,c1 + Vs,c2 = 107231.957
  Vs,c1 = 0.00 is calculated for section web core, with:
    d = 200.00
    Av = 100530.965
    fy = 444.44
    s = 250.00
  Vs,c1 is multiplied by   Col,c1 = 0.00
    s/d = 1.25
  Vs,c2 = 107231.957 is calculated for section flange core, with:
    d = 600.00
    Av = 100530.965
    fy = 444.44
    s = 250.00
  Vs,c2 is multiplied by   Col,c2 = 1.00
    s/d = 0.41666667
  Vf ((11-3)-(11.4), ACI 440) = 477918.239
    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) = 907.00
  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 <= 1.1791E+006
    bw = 450.00
```


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

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

Constant Properties

Knowledge Factor,   = 0.90
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lb = 300.00
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 = 18052.15
Shear Force, V2 = 8272.465
Shear Force, V3 = 17.12416
Axial Force, F = -21341.949
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1539.38

-Compression: Asl,com = 2475.575
            -Middle: Asl,mid = 2676.637
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
            -Tension: Asl,ten,jacket = 1231.504
         -Compression: Asl,com,jacket = 1859.823
            -Middle: Asl,mid,jacket = 2060.885
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
            -Tension: Asl,ten,core = 307.8761
         -Compression: Asl,com,core = 615.7522
            -Middle: Asl,mid,core = 615.7522
Mean Diameter of Tension Reinforcement, DbL = 16.57143

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = θ* θu = 0.00101063
 θu = θy + θp = 0.00112292

 - Calculation of θy -

 θy = (My*Ls/3)/EIeff = 0.00112292 ((4.29),Biskinis Phd))
 My = 5.5414E+008
 Ls = M/V (with Ls > 0.1*L and Ls < 2*L) = 1054.192
 From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7341E+014
    factor = 0.30
      Ag = 562500.00
      Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333
      N = 21341.949
    Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7803E+014

Calculation of Yielding Moment My

Calculation of θy and My according to Annex 7 -

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

 φy = Min(φy_ten, φy_com)
 φy_ten = 3.1142058E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 352.1657
    d = 707.00
     ξy = 0.20025732
    A = 0.01005314
    B = 0.00472011
     with pt = 0.00229194
        pc = 0.00368581
        pv = 0.00398517
        N = 21341.949
        b = 950.00
         δ" = 0.06082037
 φy_comp = 1.5783736E-005
 with fc* (12.3, (ACI 440)) = 33.25688
    fc = 33.00
    fl = 0.43533893
    b = bmax = 950.00
    h = hmax = 750.00
    Ag = 0.5625
       ρg = pt + pc + pv = 0.00996292
    rc = 40.00
    Ae/Ac = 0.30198841
    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 = 0.19868723
     A = 0.00989126
     B = 0.00462988
      with Es = 200000.00
CONFIRMATION:  y = 0.19960317 < t/d
-----------------------------------------------------------
-----------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------
Lap Length: ld/ld,min = 0.38756552
lb = 300.00
ld = 774.0627
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
     = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 524.4464
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
     t = 1.00
     s = 0.80
     e = 1.00
  cb = 25.00
  Ktr = 1.37392
    Atr = Min(Atr_x,Atr_y) = 257.6106
    where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
    s = Max(s_external,s_internal) = 250.00
    n = 30.00


-----------------------------------------------------------
 - 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 = 0.56344875
   d = d_external = 707.00
   s = s_external = 0.00
 -   t =   s1 +   s2 + 2*tf/bw*(ffe/fs) = 0.00568407
   jacket:   s1 = Av1*Lstir1/(s1*Ag) = 0.00301593
        Av1 = 78.53982, is the area of every stirrup parallel to loading (shear) direction
        Lstir1 = 2160.00, is the total Length of all stirrups parallel to loading (shear) direction
        s1 = 100.00
   core:    s2 = Av2*Lstir2/(s2*Ag) = 0.00056047
        Av2 = 50.26548, is the area of every stirrup parallel to loading (shear) direction
        Lstir2 = 1568.00, is the total Length of all stirrups parallel to loading (shear) direction
        s2 = 250.00
   The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
   where   f = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises   f to steel strength
   All these variables have already been given in Shear control ratio calculation.
   For the normalisation fs of jacket is used.
     NUD = 21341.949
     Ag = 562500.00
     f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 26.93333
     fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein =
529.9972
     fytE = (fy_ext_Trans_Reinf*  s1+fy_int_Trans_Reinf*  s2)/(  s1+  s2) = 538.146
pl = Area_Tot_Long_Rein/(b*d) = 0.00996292
   b = 950.00
   d = 707.00
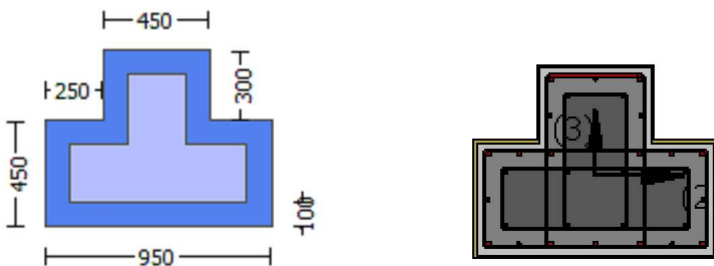   f'cE = 26.93333
-----------------------------------------------------------
End Of Calculation of Chord Rotation Capacity for element: column JTC1 of floor 1
At local axis: 2
```

Integration Section: (b)

Calculation No. 7

column C1, Floor 1

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

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (3)

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

Constant Properties

Knowledge Factor, = 0.90
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of y for displacement ductility demand,

the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.44
##
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = lb = 300.00
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 = 34209.595
Shear Force, Va = -17.12416
EDGE -B-
Bending Moment, Mb = 18052.15
Shear Force, Vb = 17.12416
BOTH EDGES
Axial Force, F = -21341.949
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
    -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1539.38
    -Compression: Asl,com = 2475.575
        -Middle: Asl,mid = 2676.637
Mean Diameter of Tension Reinforcement, DbL,ten = 16.57143

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR =   *Vn = 1.0171E+006
Vn ((10.3), ASCE 41-17) = knl*VColO = 1.1301E+006
   VCol = 1.1301E+006
   knl = 1.00
      displacement_ductility_demand = 2.1991281E-005

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 = 20.80, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)

M/Vd = 2.00

  Mu = 18052.15

  Vu = 17.12416

d = 0.8*h = 600.00

Nu = 21341.949

Ag = 337500.00

From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 824756.036

 where:

Vs,jacket = Vs,j1 + Vs,j2 = 753982.237

Vs,j1 = 471238.898 is calculated for section web jacket, with:

  d = 600.00

  Av = 157079.633

  fy = 500.00

  s = 100.00

Vs,j1 is multiplied by Col,j1 = 1.00

  s/d = 0.16666667

Vs,j2 = 282743.339 is calculated for section flange jacket, with:

  d = 360.00

  Av = 157079.633

  fy = 500.00

  s = 100.00

Vs,j2 is multiplied by Col,j2 = 1.00

  s/d = 0.27777778

Vs,core = Vs,c1 + Vs,c2 = 70773.799

Vs,c1 = 70773.799 is calculated for section web core, with:

  d = 440.00

  Av = 100530.965

  fy = 400.00

  s = 250.00

Vs,c1 is multiplied by Col,c1 = 1.00

  s/d = 0.56818182

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

  d = 200.00

  Av = 100530.965

  fy = 400.00

  s = 250.00

Vs,c2 is multiplied by Col,c2 = 0.00

  s/d = 1.25

Vf ((11-3)-(11.4), ACI 440) = 372533.843

 ψ_f = 0.95, for fully-wrapped sections

wf/sf = 1 (FRP strips adjacent to one another).

In (11.3) sin β + cos β is replaced with (cot θ +cotα)sinα which is more a generalised expression,

where θ is the angle of the crack direction (see KANEPE).

This later relation, considered as a function Vf(θ, α), is implemented for every different fiber orientation ai,

as well as for 2 crack directions, θ =45° and θ =-45° to take into consideration the cyclic seismic loading.

orientation 1: α1 = b1 + 90° = 90.00

Vf = Min(|Vf(45, α1)|,|Vf(-45,a1)|), with:

total thickness per orientation, tf1 = NL*t/NoDir = 1.016

dfv = d (figure 11.2, ACI 440) = 707.00

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 <= 818016.733

  bw = 450.00

----

displacement_ductility_demand is calculated as μ / μy

- Calculation of μ / μy for END B -

 for rotation axis 2 and integ. section (b)

From analysis, chord rotation θ = 2.4694420E-008

y = (My*Ls/3)/EIeff = 0.00112292 ((4.29),Biskinis Phd))
  My = 5.5414E+008
  Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1054.192
  From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7341E+014
    factor = 0.30
      Ag = 562500.00
      Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333
      N = 21341.949
    Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7803E+014

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7 -

Assuming neutral axis within flange (y < t/d, compression zone rectangular) with:
flange width, b = 950.00
web width, bw = 450.00
flange thickness, t = 450.00
----
  y = Min(y_ten, y_com)
  y_ten = 3.1142058E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 352.1657
    d = 707.00
      y = 0.20025732
    A = 0.01005314
    B = 0.00472011
     with pt = 0.00229194
        pc = 0.00368581
        pv = 0.00398517
        N = 21341.949
        b = 950.00
         " = 0.06082037
  y_comp = 1.5783736E-005
 with fc* (12.3, (ACI 440)) = 33.25688
    fc = 33.00
    fl = 0.43533893
    b = bmax = 950.00
    h = hmax = 750.00
    Ag = 0.5625
       g = pt + pc + pv = 0.00996292
    rc = 40.00
    Ae/Ac = 0.30198841
    Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
   effective strain from (12.5) and (12.12), efe = 0.004
    fu = 0.01
   Ef = 64828.00
  Ec = 26999.444
   y = 0.19868723
  A = 0.00989126
  B = 0.00462988
   with Es = 200000.00
CONFIRMATION: y = 0.19960317 < t/d

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.38756552
lb = 300.00
ld = 774.0627
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
   = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 524.4464
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=

8.3 MPa (22.5.3.1, ACI 318-14)
    t = 1.00
    s = 0.80
    e = 1.00
  cb = 25.00
  Ktr = 1.37392
  Atr = Min(Atr_x,Atr_y) = 257.6106
    where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
    s = Max(s_external,s_internal) = 250.00
    n = 30.00

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

Calculation No. 8

column C1, Floor 1

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

Analysis: Uniform +X

Check: Chord rotation capacity (u)

Edge: End

Local Axis: (3)

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

Constant Properties

Knowledge Factor, = 0.90
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56

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Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 555.55
##
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.02437
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
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 = -0.00053663
EDGE -B-
Shear Force, Vb = 0.00053663
BOTH EDGES
Axial Force, F = -20792.011
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
    -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 1539.38
    -Compression: Asl,com = 2475.575
       -Middle: Asl,mid = 2676.637

Calculation of Shear Capacity ratio , Ve/Vr = 0.56344875
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 624335.951
with

Mpr1 = Max(Mu1+ , Mu1-) = 9.3650E+008
  Mu1+ = 6.7320E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
  Mu1- = 9.3650E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 9.3650E+008
  Mu2+ = 6.7320E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
  Mu2- = 9.3650E+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 = 9.1136953E-006
Mu = 6.7320E+008
----
with full section properties:
  b = 950.00
  d = 707.00
  d' = 43.00
  v = 0.00093808
    N = 20792.011
  fc = 33.00
  ε_{co} (5A.5, TBDY) = 0.002
  Final value of ε_{cu}: ε_{cu}^* = shear_factor * Max(ε_{cu}, ε_{cc}) = 0.01209008
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: ε_{cu} = 0.01209008
      ω_{we} ((5.4c), TBDY) = $\alpha_{se}^* \rho_{sh,min}^*fywe/fce+Min(\alpha_{fx}, \alpha_{fy})$ = 0.04611842
    where $\alpha_f = \alpha_f^*\rho_f^*ffe/fce$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

      α_{fx} = 0.03444474
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A4.4.3(6), ρ_f = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

      α_{fy} = 0.03444474
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A4.4.3(6), ρ_f = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

      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) = (ase1*Aext+ase2*Aint)/Asec = 0.53375773
      ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
      The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
      of the rectangular sections confinement, which is expressed by (5.4d).
      The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
      "Theoretical Stress-Strain Model for Confined Concrete."
      J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
      Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and

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

Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and is calculated by reducing all the dimensions of the area Aconf,max1 by a length equal to half the clear spacing between external hoops.

AnoConf1 = 173066.667 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).

ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773

The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization of the rectangular sections confinement, which is expressed by (5.4d).

The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988) "Theoretical Stress-Strain Model for Confined Concrete."

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

Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.

Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and is calculated by reducing all the dimensions of the area Aconf,max2 by a length equal to half the clear spacing between internal hoops.

AnoConf2 = 110709.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).

psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578

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

----

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578

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

Lstir1 (Length of stirrups along Y) = 2160.00

Astir1 (stirrups area) = 78.53982

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

Lstir2 (Length of stirrups along Y) = 1568.00

Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307

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

Lstir1 (Length of stirrups along X) = 2560.00

Astir1 (stirrups area) = 78.53982

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

Lstir2 (Length of stirrups along X) = 1968.00

Astir2 (stirrups area) = 50.26548

Asec = 562500.00

s1 = 100.00

s2 = 250.00

fywe1 = 694.45

fywe2 = 555.55

fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00224367

c = confinement factor = 1.02437

y1 = 0.00143155

sh1 = 0.00458096

ft1 = 458.0986

fy1 = 381.7488

su1 = 0.00550601

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

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/ld = 0.31005242

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 = 381.7488

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

y2 = 0.00143155

sh2 = 0.00458096

ft2 = 453.4475

fy2 = 377.8729

su2 = 0.00550601

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
    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 = 377.8729
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00143155
  shv = 0.00458096
 ftv = 455.2307
 fyv = 379.359
  suv = 0.00550601
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.31005242
    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 = 379.359
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.02651348
  2 = Asl,com/(b*d)*(fs2/fc) = 0.04220509
  v = Asl,mid/(b*d)*(fsv/fc) = 0.04581238
and confined core properties:
  b = 890.00
  d = 677.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.80412
  cc (5A.5, TBDY) = 0.00224367
    c = confinement factor = 1.02437
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.029555
   2 = Asl,com/(b*d)*(fs2/fc) = 0.0470467
   v = Asl,mid/(b*d)*(fsv/fc) = 0.0510678
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.14547789
Mu = MRc (4.14) = 6.7320E+008
 u =   su (4.1) = 9.1136953E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
    = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
    t = 1.00
    s = 0.80
    e = 1.00
  cb = 25.00
  Ktr = 1.37392
   Atr = Min(Atr_x,Atr_y) = 257.6106

where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 30.00

Calculation of Mu1-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 u = 9.8526632E-006
Mu = 9.3650E+008
----
with full section properties:
 b = 450.00
 d = 707.00
 d' = 43.00
 v = 0.00198039
   N = 20792.011
 fc = 33.00
  co (5A.5, TBDY) = 0.002
 Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01209008
   The Shear_factor is considered equal to 1 (pure moment strength)
   From (5.4b), TBDY: cu = 0.01209008
     we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.04611842
   where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
   ----
     fx = 0.03444474
   Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
   af = 0.28545185
   with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461
   ----
     fy = 0.03444474
   Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
   af = 0.28545185
   with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

      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 = 0.53375773
        ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
                is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
        Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
                is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                equal to half the clear spacing between external hoops.
        AnoConf1 = 173066.667 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
      ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773

The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 110709.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

----

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 453.4475
fy1 = 377.8729
su1 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 377.8729
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 458.0986
fy2 = 381.7488
su2 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
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 = 381.7488
   with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
 yv = 0.00143155
 shv = 0.00458096
ftv = 455.2307
fyv = 379.359
 suv = 0.00550601
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.31005242
   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 = 379.359
   with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.08909964
  2 = Asl,com/(b*d)*(fs2/fc) = 0.05597289
  v = Asl,mid/(b*d)*(fsv/fc) = 0.09671502
and confined core properties:
 b = 390.00
 d = 677.00
 d' = 13.00
 fcc (5A.2, TBDY) = 33.80412
  cc (5A.5, TBDY) = 0.00224367
   c = confinement factor = 1.02437
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.10736299
   2 = Asl,com/(b*d)*(fs2/fc) = 0.06744603
   v = Asl,mid/(b*d)*(fsv/fc) = 0.11653935
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.20956863
Mu = MRc (4.14) = 9.3650E+008
 u =   su (4.1) = 9.8526632E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
   = 1
 db = 16.66667
 Mean strength value of all re-bars: fy = 655.558
 Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
   t = 1.00
   s = 0.80
   e = 1.00
 cb = 25.00
 Ktr = 1.37392
  Atr = Min(Atr_x,Atr_y) = 257.6106
  where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
  s = Max(s_external,s_internal) = 250.00
  n = 30.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 9.1136953E-006
Mu = 6.7320E+008
----
with full section properties:
  b = 950.00
  d = 707.00
  d' = 43.00
  ν = 0.00093808
    N = 20792.011
  fc = 33.00
  εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.01209008
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.01209008
      ωwe ((5.4c), TBDY) = αse*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.04611842
    where ωf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

      ωfx = 0.03444474
    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
    αf = 0.28545185
    with Unconfined area = ((bmax-2R)^2+ (hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A 4.4.3(6), ρf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

      ωfy = 0.03444474
    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
    αf = 0.28545185
    with Unconfined area = ((bmax-2R)^2+ (hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A 4.4.3(6), ρf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

      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 = 0.53375773
        αse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
              is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
        Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
              is calculated by reducing all the dimensions of the area Aconf,max1 by a length
              equal to half the clear spacing between external hoops.
        AnoConf1 = 173066.667 is the unconfined external core area which is equal to Σbi2/6 as defined at (A.2).
      αse2 (>=αse1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and

is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 110709.333 is the unconfined internal core area which is equal to $b_{i2}/6$ as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
```
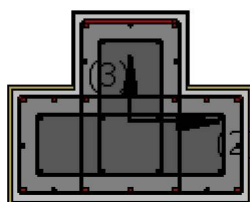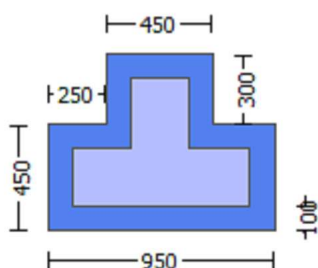-----------------------------------------------------------------
```
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548
```
-----------------------------------------------------------------
```
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548
```
-----------------------------------------------------------------
```
Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 458.0986
fy1 = 381.7488
su1 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 381.7488
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 453.4475
fy2 = 377.8729
su2 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
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 = 377.8729
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00143155
shv = 0.00458096

ftv = 455.2307
fyv = 379.359
  suv = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.31005242
     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 = 379.359
     with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.02651348
  2 = Asl,com/(b*d)*(fs2/fc) = 0.04220509
  v = Asl,mid/(b*d)*(fsv/fc) = 0.04581238
and confined core properties:
  b = 890.00
  d = 677.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.80412
   cc (5A.5, TBDY) = 0.00224367
    c = confinement factor = 1.02437
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.029555
   2 = Asl,com/(b*d)*(fs2/fc) = 0.0470467
   v = Asl,mid/(b*d)*(fsv/fc) = 0.0510678
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.14547789
Mu = MRc (4.14) = 6.7320E+008
 u =   su (4.1) = 9.1136953E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
   = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
   t = 1.00
   s = 0.80
   e = 1.00
  cb = 25.00
  Ktr = 1.37392
   Atr = Min(Atr_x,Atr_y) = 257.6106
   where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
   s = Max(s_external,s_internal) = 250.00
   n = 30.00

Calculation of Mu2-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
 u = 9.8526632E-006

Mu = 9.3650E+008

----

with full section properties:
  b = 450.00
  d = 707.00
  d' = 43.00
  v = 0.00198039
    N = 20792.011
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01209008
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.01209008
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.04611842
    where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----
      fx = 0.03444474
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461
    ----
      fy = 0.03444474
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

      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 = 0.53375773
        ase1 = Max((((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
                is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
        Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
                is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                equal to half the clear spacing between external hoops.
      AnoConf1 = 173066.667 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
      ase2 (>=ase1) = Max((((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
                is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
        Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
                is calculated by reducing all the dimensions of the area Aconf,max2 by a length
                equal to half the clear spacing between internal hoops.
      AnoConf2 = 110709.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
      psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578

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

----

 psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
 psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
  Lstir1 (Length of stirrups along Y) = 2160.00
  Astir1 (stirrups area) = 78.53982
 psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
  Lstir2 (Length of stirrups along Y) = 1568.00
  Astir2 (stirrups area) = 50.26548

----

 psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
 psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
  Lstir1 (Length of stirrups along X) = 2560.00
  Astir1 (stirrups area) = 78.53982
 psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
  Lstir2 (Length of stirrups along X) = 1968.00
  Astir2 (stirrups area) = 50.26548

  Asec = 562500.00
  s1 = 100.00
  s2 = 250.00
  fywe1 = 694.45
  fywe2 = 555.55
  fce = 33.00
 From ((5.A5), TBDY), TBDY: cc = 0.00224367
  c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 453.4475
fy1 = 377.8729
su1 = 0.00550601
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 lo/lou,min = lb/ld = 0.31005242
 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 = 377.8729
 with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 458.0986
fy2 = 381.7488
su2 = 0.00550601
 using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
 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 = 381.7488
 with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00143155
shv = 0.00458096
ftv = 455.2307
fyv = 379.359
suv = 0.00550601
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

    lo/lou,min = lb/ld = 0.31005242
     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 = 379.359
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.08909964
  2 = Asl,com/(b*d)*(fs2/fc) = 0.05597289
  v = Asl,mid/(b*d)*(fsv/fc) = 0.09671502
and confined core properties:
  b = 390.00
  d = 677.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.80412
   cc (5A.5, TBDY) = 0.00224367
    c = confinement factor = 1.02437
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.10736299
   2 = Asl,com/(b*d)*(fs2/fc) = 0.06744603
   v = Asl,mid/(b*d)*(fsv/fc) = 0.11653935
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.20956863
Mu = MRc (4.14) = 9.3650E+008
 u =   su (4.1) = 9.8526632E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
   = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^ 0.5 < =
8.3 MPa (22.5.3.1, ACI 318-14)
   t = 1.00
   s = 0.80
   e = 1.00
  cb = 25.00
  Ktr = 1.37392
  Atr = Min(Atr_x,Atr_y) = 257.6106
  where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
  s = Max(s_external,s_internal) = 250.00
  n = 30.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.1081E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.1081E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 1.1081E+006
  knl = 1 (zero step-static loading)

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

   = 1 (normal-weight concrete)

Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)

M/Vd = 4.00
 Mu = 761.1315
 Vu = 0.00053663
d = 0.8*h = 600.00
Nu = 20792.011
Ag = 337500.00
From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 916401.511
 where:
Vs,jacket = Vs,j1 + Vs,j2 = 837764.743
 Vs,j1 = 523602.964 is calculated for section web jacket, with:
  d = 600.00
  Av = 157079.633
  fy = 555.56
  s = 100.00
 Vs,j1 is multiplied by Col,j1 = 1.00
  s/d = 0.16666667
 Vs,j2 = 314161.779 is calculated for section flange jacket, with:
  d = 360.00
  Av = 157079.633
  fy = 555.56
  s = 100.00
 Vs,j2 is multiplied by Col,j2 = 1.00
  s/d = 0.27777778
Vs,core = Vs,c1 + Vs,c2 = 78636.768
 Vs,c1 = 78636.768 is calculated for section web core, with:
  d = 440.00
  Av = 100530.965
  fy = 444.44
  s = 250.00
 Vs,c1 is multiplied by Col,c1 = 1.00
  s/d = 0.56818182
 Vs,c2 = 0.00 is calculated for section flange core, with:
  d = 200.00
  Av = 100530.965
  fy = 444.44
  s = 250.00
 Vs,c2 is multiplied by Col,c2 = 0.00
  s/d = 1.25
 Vf ((11-3)-(11.4), ACI 440) = 372533.843
  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) = 707.00
 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 <= 930841.148
  bw = 450.00

Calculation of Shear Strength at edge 2, Vr2 = 1.1081E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
 VCol0 = 1.1081E+006
 knl = 1 (zero step-static loading)

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

= 1 (normal-weight concrete)

Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)

M/Vd = 4.00

  Mu = 761.1315

  Vu = 0.00053663

d = 0.8*h = 600.00

Nu = 20792.011

Ag = 337500.00

From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 916401.511

where:

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

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

   d = 600.00

   Av = 157079.633

   fy = 555.56

   s = 100.00

 Vs,j1 is multiplied by   Col,j1 = 1.00

   s/d = 0.16666667

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

   d = 360.00

   Av = 157079.633

   fy = 555.56

   s = 100.00

 Vs,j2 is multiplied by   Col,j2 = 1.00

   s/d = 0.27777778

 Vs,core = Vs,c1 + Vs,c2 = 78636.768

 Vs,c1 = 78636.768 is calculated for section web core, with:

   d = 440.00

   Av = 100530.965

   fy = 444.44

   s = 250.00

 Vs,c1 is multiplied by   Col,c1 = 1.00

   s/d = 0.56818182

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

   d = 200.00

   Av = 100530.965

   fy = 444.44

   s = 250.00

 Vs,c2 is multiplied by   Col,c2 = 0.00

   s/d = 1.25

 Vf ((11-3)-(11.4), ACI 440) = 372533.843

   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) = 707.00

 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 <= 930841.148

   bw = 450.00

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

Start Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1

At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjtcs

Constant Properties

Knowledge Factor,   = 0.90
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 555.55
##
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.02437
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
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 = -4.4410684E-008
EDGE -B-
Shear Force, Vb = 4.4410684E-008
BOTH EDGES
Axial Force, F = -20792.011
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 6691.592

Longitudinal Reinforcement Area Distribution (in 3 divisions)
    -Tension: Asl,ten = 1539.38
   -Compression: Asl,com = 1539.38
      -Middle: Asl,mid = 3612.832

Calculation of Shear Capacity ratio , Ve/Vr = 0.39733369
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 646432.814
with
Mpr1 = Max(Mu1+ , Mu1-) = 9.6965E+008
  Mu1+ = 9.6965E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
  Mu1- = 9.6965E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 9.6965E+008
  Mu2+ = 9.6965E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
  Mu2- = 9.6965E+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 = 7.3807483E-006
Mu = 9.6965E+008
----
with full section properties:
  b = 450.00
  d = 907.00
  d' = 43.00
  v = 0.0015437
    N = 20792.011
  fc = 33.00
  εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.01209008
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.01209008
      ωwe ((5.4c), TBDY) = αse* ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.04611842
    where ωf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

      ωfx = 0.03444474
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2 + (hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

      ωfy = 0.03444474
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2 + (hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

      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 = 0.53375773
ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max1 by a length
equal to half the clear spacing between external hoops.
AnoConf1 = 173066.667 is the unconfined external core area which is equal to   bi2/6 as defined at (A.2).
ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 110709.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 458.0986
fy1 = 381.7488
su1 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 381.7488
  with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 458.0986
fy2 = 381.7488
su2 = 0.00550601
  using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
  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 = 381.7488
  with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00143155
shv = 0.00458096
ftv = 452.7869
fyv = 377.3224
suv = 0.00550601
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.31005242
  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 = 377.3224
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04363047
2 = Asl,com/(b*d)*(fs2/fc) = 0.04363047
v = Asl,mid/(b*d)*(fsv/fc) = 0.10121073
and confined core properties:
b = 390.00
d = 877.00
d' = 13.00
fcc (5A.2, TBDY) = 33.80412
cc (5A.5, TBDY) = 0.00224367
  c = confinement factor = 1.02437
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05206495
2 = Asl,com/(b*d)*(fs2/fc) = 0.05206495
v = Asl,mid/(b*d)*(fsv/fc) = 0.12077642
Case/Assumption: Unconfinesd full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.17751206
Mu = MRc (4.14) = 9.6965E+008
u =   su (4.1) = 7.3807483E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783

Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
  = 1
 db = 16.66667
 Mean strength value of all re-bars: fy = 655.558
 Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but $fc^{0.5}$ <= 8.3 MPa (22.5.3.1, ACI 318-14)
  t = 1.00
  s = 0.80
  e = 1.00
 cb = 25.00
 Ktr = 1.37392
 Atr = Min(Atr_x,Atr_y) = 257.6106
 where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
 s = Max(s_external,s_internal) = 250.00
 n = 30.00

Calculation of Mu1-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 u = 7.3807483E-006
Mu = 9.6965E+008
----
with full section properties:
 b = 450.00
 d = 907.00
 d' = 43.00
 v = 0.0015437
  N = 20792.011
 fc = 33.00
 co (5A.5, TBDY) = 0.002
 Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01209008
  The Shear_factor is considered equal to 1 (pure moment strength)
  From (5.4b), TBDY: cu = 0.01209008
   we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.04611842
  where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
  ----
  fx = 0.03444474
  Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
  af = 0.28545185
  with Unconfined area = $((bmax-2R)^2+(hmax-2R)^2)/3$ = 160566.667
   bmax = 950.00
   hmax = 750.00
   From EC8 A4.4.3(6), pf = 2tf/bw = 0.00451556
    bw = 450.00
   effective stress from (A.35), ff,e = 881.8461
  ----
  fy = 0.03444474
  Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
  af = 0.28545185
  with Unconfined area = $((bmax-2R)^2+(hmax-2R)^2)/3$ = 160566.667
   bmax = 950.00
   hmax = 750.00
   From EC8 A4.4.3(6), pf = 2tf/bw = 0.00451556
    bw = 450.00
   effective stress from (A.35), ff,e = 881.8461

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

The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max1 by a length
equal to half the clear spacing between external hoops.
AnoConf1 = 173066.667 is the unconfined external core area which is equal to $bi2/6$ as defined at (A.2).
ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 110709.333 is the unconfined internal core area which is equal to $bi2/6$ as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

```
        -----------------------------------------------------------------
        psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
            Lstir1 (Length of stirrups along Y) = 2160.00
            Astir1 (stirrups area) = 78.53982
        psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
            Lstir2 (Length of stirrups along Y) = 1568.00
            Astir2 (stirrups area) = 50.26548
        -----------------------------------------------------------------
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
            Lstir1 (Length of stirrups along X) = 2560.00
            Astir1 (stirrups area) = 78.53982
        psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
            Lstir2 (Length of stirrups along X) = 1968.00
            Astir2 (stirrups area) = 50.26548
        -----------------------------------------------------------------

        Asec = 562500.00
        s1 = 100.00
        s2 = 250.00
      fywe1 = 694.45
      fywe2 = 555.55
      fce = 33.00
   From ((5.A5), TBDY), TBDY:  cc = 0.00224367
        c = confinement factor = 1.02437
  y1 = 0.00143155
  sh1 = 0.00458096
 ft1 = 458.0986
fy1 = 381.7488
  su1 = 0.00550601
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.31005242
    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 = 381.7488
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
```

y2 = 0.00143155
sh2 = 0.00458096
ft2 = 458.0986
fy2 = 381.7488
su2 = 0.00550601
  using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
  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 = 381.7488
  with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00143155
shv = 0.00458096
ftv = 452.7869
fyv = 377.3224
suv = 0.00550601
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.31005242
  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 = 377.3224
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.04363047
  2 = Asl,com/(b*d)*(fs2/fc) = 0.04363047
  v = Asl,mid/(b*d)*(fsv/fc) = 0.10121073
and confined core properties:
  b = 390.00
  d = 877.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.80412
  cc (5A.5, TBDY) = 0.00224367
    c = confinement factor = 1.02437
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.05206495
  2 = Asl,com/(b*d)*(fs2/fc) = 0.05206495
  v = Asl,mid/(b*d)*(fsv/fc) = 0.12077642
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.17751206
Mu = MRc (4.14) = 9.6965E+008
 u =   su (4.1) = 7.3807483E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
  = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)

```
    t = 1.00
    s = 0.80
    e = 1.00
   cb = 25.00
  Ktr = 1.37392
   Atr = Min(Atr_x,Atr_y) = 257.6106
   where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
   s = Max(s_external,s_internal) = 250.00
   n = 30.00
```


Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 7.3807483E-006
Mu = 9.6965E+008
----
with full section properties:
  b = 450.00
  d = 907.00
  d' = 43.00
  v = 0.0015437
    N = 20792.011
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01209008
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: cu = 0.01209008
       we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx,   fy) = 0.04611842
     where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
     ----
       fx = 0.03444474
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2 + (hmax-2R)^2)/3 = 160566.667
       bmax = 950.00
       hmax = 750.00
       From EC8 A4.4.3(6), pf = 2tf/bw = 0.00451556
         bw = 450.00
       effective stress from (A.35), ff,e = 881.8461
     ----
       fy = 0.03444474
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2 + (hmax-2R)^2)/3 = 160566.667
       bmax = 950.00
       hmax = 750.00
       From EC8 A4.4.3(6), pf = 2tf/bw = 0.00451556
         bw = 450.00
       effective stress from (A.35), ff,e = 881.8461

       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 = 0.53375773
         ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
         The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
         of the rectangular sections confinement, which is expressed by (5.4d).
         The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
         "Theoretical Stress-Strain Model for Confined Concrete."
         J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
         Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and

is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max1 by a length
equal to half the clear spacing between external hoops.
AnoConf1 = 173066.667 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 110709.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 458.0986
fy1 = 381.7488
su1 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 381.7488
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 458.0986
fy2 = 381.7488
su2 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
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 = 381.7488
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00143155
shv = 0.00458096
ftv = 452.7869
fyv = 377.3224
suv = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 377.3224
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04363047
2 = Asl,com/(b*d)*(fs2/fc) = 0.04363047
v = Asl,mid/(b*d)*(fsv/fc) = 0.10121073
and confined core properties:
b = 390.00
d = 877.00
d' = 13.00
fcc (5A.2, TBDY) = 33.80412
cc (5A.5, TBDY) = 0.00224367
c = confinement factor = 1.02437
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05206495
2 = Asl,com/(b*d)*(fs2/fc) = 0.05206495
v = Asl,mid/(b*d)*(fsv/fc) = 0.12077642
Case/Assumption: Unconfinesd full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.17751206
Mu = MRc (4.14) = 9.6965E+008
u =   su (4.1) = 7.3807483E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 16.66667
Mean strength value of all re-bars: fy = 655.558
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
t = 1.00
s = 0.80
e = 1.00
cb = 25.00
Ktr = 1.37392
Atr = Min(Atr_x,Atr_y) = 257.6106

where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 30.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 7.3807483E-006
Mu = 9.6965E+008
----
with full section properties:
  b = 450.00
  d = 907.00
  d' = 43.00
  v = 0.0015437
    N = 20792.011
  fc = 33.00
  εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.01209008
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.01209008
      ωwe ((5.4c), TBDY) = ρse* αsh,min*fywe/fce+Min(ρfx, ρfy) = 0.04611842
    where ρf = αf*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

      ρfx = 0.03444474
    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
    αf = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A 4.4.3(6), pf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

      ρfy = 0.03444474
    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
    αf = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A 4.4.3(6), pf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

      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 = 0.53375773
        αse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
              is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
        Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
              is calculated by reducing all the dimensions of the area Aconf,max1 by a length
              equal to half the clear spacing between external hoops.
        AnoConf1 = 173066.667 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
      αse2 (>=αse1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773

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The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 110709.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548

----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 458.0986
fy1 = 381.7488
su1 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 381.7488
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 458.0986
fy2 = 381.7488
su2 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
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 = 381.7488
   with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
 yv = 0.00143155
 shv = 0.00458096
ftv = 452.7869
fyv = 377.3224
 suv = 0.00550601
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.31005242
   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 = 377.3224
   with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.04363047
  2 = Asl,com/(b*d)*(fs2/fc) = 0.04363047
  v = Asl,mid/(b*d)*(fsv/fc) = 0.10121073
and confined core properties:
 b = 390.00
 d = 877.00
 d' = 13.00
 fcc (5A.2, TBDY) = 33.80412
  cc (5A.5, TBDY) = 0.00224367
   c = confinement factor = 1.02437
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.05206495
  2 = Asl,com/(b*d)*(fs2/fc) = 0.05206495
  v = Asl,mid/(b*d)*(fsv/fc) = 0.12077642
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.17751206
Mu = MRc (4.14) = 9.6965E+008
 u =   su (4.1) = 7.3807483E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
  = 1
 db = 16.66667
 Mean strength value of all re-bars: fy = 655.558
 Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
   t = 1.00
   s = 0.80
   e = 1.00
 cb = 25.00
 Ktr = 1.37392
  Atr = Min(Atr_x,Atr_y) = 257.6106
  where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
  s = Max(s_external,s_internal) = 250.00
  n = 30.00


```
--------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.6269E+006
--------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 1.6269E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 1.6269E+006
  knl = 1 (zero step-static loading)
----------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+  f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
----------------------------------------------------------------
    = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
    Mu = 0.62237178
    Vu = 4.4410684E-008
  d = 0.8*h = 760.00
  Nu = 20792.011
  Ag = 427500.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 1.0846E+006
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 977392.20
   Vs,j1 = 314161.779 is calculated for section web jacket, with:
     d = 360.00
     Av = 157079.633
     fy = 555.56
     s = 100.00
   Vs,j1 is multiplied by   Col,j1 = 1.00
     s/d = 0.27777778
   Vs,j2 = 663230.422 is calculated for section flange jacket, with:
     d = 760.00
     Av = 157079.633
     fy = 555.56
     s = 100.00
   Vs,j2 is multiplied by   Col,j2 = 1.00
     s/d = 0.13157895
  Vs,core = Vs,c1 + Vs,c2 = 107231.957
   Vs,c1 = 0.00 is calculated for section web core, with:
     d = 200.00
     Av = 100530.965
     fy = 444.44
     s = 250.00
   Vs,c1 is multiplied by   Col,c1 = 0.00
     s/d = 1.25
   Vs,c2 = 107231.957 is calculated for section flange core, with:
     d = 600.00
     Av = 100530.965
     fy = 444.44
     s = 250.00
   Vs,c2 is multiplied by   Col,c2 = 1.00
     s/d = 0.41666667
  Vf ((11-3)-(11.4), ACI 440) = 477918.239
    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) = 907.00
  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 <= 1.1791E+006
    bw = 450.00

Calculation of Shear Strength at edge 2, Vr2 = 1.6269E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 1.6269E+006
  knl = 1 (zero step-static loading)

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

    = 1 (normal-weight concrete)
   Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
     Mu = 0.62124232
     Vu = 4.4410684E-008
  d = 0.8*h = 760.00
  Nu = 20792.011
  Ag = 427500.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 1.0846E+006
  where:
 Vs,jacket = Vs,j1 + Vs,j2 = 977392.20
  Vs,j1 = 314161.779 is calculated for section web jacket, with:
     d = 360.00
     Av = 157079.633
     fy = 555.56
     s = 100.00
  Vs,j1 is multiplied by   Col,j1 = 1.00
     s/d = 0.27777778
  Vs,j2 = 663230.422 is calculated for section flange jacket, with:
     d = 760.00
     Av = 157079.633
     fy = 555.56
     s = 100.00
  Vs,j2 is multiplied by   Col,j2 = 1.00
     s/d = 0.13157895
 Vs,core = Vs,c1 + Vs,c2 = 107231.957
  Vs,c1 = 0.00 is calculated for section web core, with:
     d = 200.00
     Av = 100530.965
     fy = 444.44
     s = 250.00
  Vs,c1 is multiplied by   Col,c1 = 0.00
     s/d = 1.25
  Vs,c2 = 107231.957 is calculated for section flange core, with:
     d = 600.00
     Av = 100530.965
     fy = 444.44
     s = 250.00
  Vs,c2 is multiplied by   Col,c2 = 1.00
     s/d = 0.41666667
  Vf ((11-3)-(11.4), ACI 440) = 477918.239
     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) = 907.00
  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 < = 1.1791E+006
      bw =  450.00
------------------------------------------------------------
------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1
At local axis: 2


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



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

Constant Properties
------------------------------------------------------------
Knowledge Factor,    = 0.90
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lb = 300.00
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 = 118914.623
Shear Force, V2 = 8272.465
Shear Force, V3 = 17.12416
Axial Force, F = -21341.949
Longitudinal Reinforcement Area Distribution (in 2 divisions)
       -Tension: Aslt = 0.00
```

-Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
    -Tension: Asl,ten = 1539.38
   -Compression: Asl,com = 1539.38
    -Middle: Asl,mid = 3612.832
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
    -Tension: Asl,ten,jacket = 1231.504
   -Compression: Asl,com,jacket = 1231.504
    -Middle: Asl,mid,jacket = 2689.203
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
    -Tension: Asl,ten,core = 307.8761
   -Compression: Asl,com,core = 307.8761
    -Middle: Asl,mid,core = 923.6282
Mean Diameter of Tension Reinforcement, DbL = 16.57143

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $\theta_{u,R} = \, * \theta_u$ = 0.00026136
 $\theta_u = \theta_y + \theta_p$ = 0.0002904

- Calculation of θ_y -

 θ_y = (My*Ls/3)/Eleff = 0.0002904 ((4.29),Biskinis Phd))
 My = 7.6202E+008
 Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 300.00
 From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 2.6241E+014
   factor = 0.30
    Ag = 562500.00
    Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333
    N = 21341.949
   Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 8.7468E+014

Calculation of Yielding Moment My

Calculation of θ_y and My according to Annex 7 -

 θ_y = Min(θ_y_ten, θ_y_com)
 θ_y_ten = 2.6145845E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 352.1657
   d = 907.00
    y = 0.25748191
   A = 0.01654341
   B = 0.00873458
    with pt = 0.0037716
      pc = 0.0037716
      pv = 0.00885172
      N = 21341.949
      b = 450.00
       " = 0.04740904
 θ_y_comp = 9.5509837E-006
 with fc* (12.3, (ACI 440)) = 33.253
    fc = 33.00
    fl = 0.43533893
    b = bmax = 950.00
    h = hmax = 750.00
   Ag = 0.5625
      g = pt + pc + pv = 0.01639493
     rc = 40.00
     Ae/Ac = 0.29742395
     Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
   effective strain from (12.5) and (12.12), efe = 0.004
    fu = 0.01
   Ef = 64828.00

```
    Ec = 26999.444
     y = 0.25591344
     A = 0.016277
     B = 0.0085861
      with Es = 200000.00
------------------------------------------------------------
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Lap Length: ld/ld,min = 0.38756552
lb = 300.00
ld = 774.0627
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
     = 1
   db = 16.66667
   Mean strength value of all re-bars: fy = 524.4464
   Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
      t = 1.00
      s = 0.80
      e = 1.00
   cb = 25.00
   Ktr = 1.37392
    Atr = Min(Atr_x,Atr_y) = 257.6106
    where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
    s = Max(s_external,s_internal) = 250.00
    n = 30.00


------------------------------------------------------------
 - 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 = 0.39733369
   d = d_external = 907.00
   s = s_external = 0.00
 -   t =   s1 +   s2 + 2*tf/bw*(ffe/fs) = 0.00638555
   jacket:   s1 = Av1*Lstir1/(s1*Ag) = 0.00357443
       Av1 = 78.53982, is the area of every stirrup parallel to loading (shear) direction
       Lstir1 = 2560.00, is the total Length of all stirrups parallel to loading (shear) direction
       s1 = 100.00
   core:     s2 = Av2*Lstir2/(s2*Ag) = 0.00070345
       Av2 = 50.26548, is the area of every stirrup parallel to loading (shear) direction
       Lstir2 = 1968.00, is the total Length of all stirrups parallel to loading (shear) direction
       s2 = 250.00
   The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
   where   f = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises   f to steel strength
   All these variables have already been given in Shear control ratio calculation.
   For the normalisation fs of jacket is used.
    NUD = 21341.949
    Ag = 562500.00
    f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 26.93333
    fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein =
529.9972
    fytE = (fy_ext_Trans_Reinf*  s1+fy_int_Trans_Reinf*  s2)/(  s1+  s2) = 537.2876
pl = Area_Tot_Long_Rein/(b*d) = 0.01639493
   b = 450.00
   d = 907.00
    f'cE = 26.93333
------------------------------------------------------------
End Of Calculation of Chord Rotation Capacity for element: column JTC1 of floor 1
At local axis: 3
Integration Section: (b)


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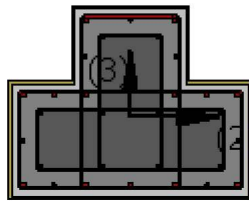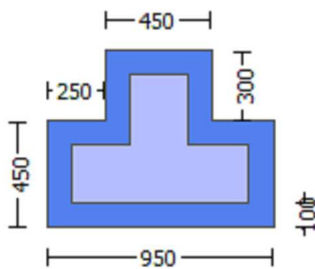```

## Calculation No. 9

column C1, Floor 1

Limit State: 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 JTC1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rcjtcs

Constant Properties
---------------------------------------------------------------
Knowledge Factor,   = 0.90
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
############################################################
Note: Especially for the calculation of  y for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket

New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.44
################################################################
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = lb = 300.00
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 = -2.0746E+007
Shear Force, Va = -6880.904
EDGE -B-
Bending Moment, Mb = 98911.173
Shear Force, Vb = 6880.904
BOTH EDGES
Axial Force, F = -21249.44
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
   -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 1539.38
   -Compression: Asl,com = 1539.38
       -Middle: Asl,mid = 3612.832
Mean Diameter of Tension Reinforcement, DbL,ten = 16.57143
-------------------------------------------------------------
-------------------------------------------------------------


Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR =   *Vn = 1.1114E+006
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 1.2349E+006
   VCol = 1.2349E+006
   knl = 1.00
      displacement_ductility_demand = 0.01719282
-------------------------------------------------------------
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 = 20.80, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)

M/Vd = 3.96705
  Mu = 2.0746E+007
  Vu = 6880.904
d = 0.8*h = 760.00
Nu = 21249.44
Ag = 427500.00
From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 976155.669
where:
Vs,jacket = Vs,j1 + Vs,j2 = 879645.943
Vs,j1 = 282743.339 is calculated for section web jacket, with:
  d = 360.00
  Av = 157079.633
  fy = 500.00
  s = 100.00
Vs,j1 is multiplied by   Col,j1 = 1.00
  s/d = 0.27777778
Vs,j2 = 596902.604 is calculated for section flange jacket, with:
  d = 760.00
  Av = 157079.633
  fy = 500.00
  s = 100.00
Vs,j2 is multiplied by   Col,j2 = 1.00
  s/d = 0.13157895
Vs,core = Vs,c1 + Vs,c2 = 96509.726
Vs,c1 = 0.00 is calculated for section web core, with:
  d = 200.00
  Av = 100530.965
  fy = 400.00
  s = 250.00
Vs,c1 is multiplied by   Col,c1 = 0.00
  s/d = 1.25
Vs,c2 = 96509.726 is calculated for section flange core, with:
  d = 600.00
  Av = 100530.965
  fy = 400.00
  s = 250.00
Vs,c2 is multiplied by   Col,c2 = 1.00
  s/d = 0.41666667
Vf ((11-3)-(11.4), ACI 440) = 477918.239
  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) = 907.00
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 <= 1.0362E+006
  bw = 450.00
-----------------------------------------------------------

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

 - Calculation of   / y for END A -
 for rotation axis 3 and integ. section (a)
-----------------------------------------------------------
From analysis, chord rotation   = 5.0174207E-005
 y = (My*Ls/3)/EIeff = 0.00291832 ((4.29),Biskinis Phd))
My = 7.6198E+008
Ls = M/V (with Ls > 0.1*L and Ls < 2*L) = 3014.959

From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 2.6241E+014
   factor = 0.30
     Ag = 562500.00
     Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333
     N = 21249.44
  Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 8.7468E+014
------------------------------------------------------------
------------------------------------------------------------

Calculation of Yielding Moment My
------------------------------------------------------------
Calculation of $\phi$y and My according to Annex 7 -
------------------------------------------------------------
 $\phi$y = Min($\phi$y_ten, $\phi$y_com)
 $\phi$y_ten = 2.6145517E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 352.1657
   d = 907.00
    y = 0.2574726
  A = 0.01654277
  B = 0.00873394
   with pt = 0.0037716
     pc = 0.0037716
     pv = 0.00885172
     N = 21249.44
     b = 450.00
      " = 0.04740904
 $\phi$y_comp = 9.5510798E-006
 with fc* (12.3, (ACI 440)) = 33.253
   fc = 33.00
   fl = 0.43533893
   b = bmax = 950.00
   h = hmax = 750.00
   Ag = 0.5625
     g = pt + pc + pv = 0.01639493
    rc = 40.00
    Ae/Ac = 0.29742395
    Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
   effective strain from (12.5) and (12.12), efe = 0.004
    fu = 0.01
  Ef = 64828.00
  Ec = 26999.444
   y = 0.25591086
  A = 0.01627751
  B = 0.0085861
   with Es = 200000.00
------------------------------------------------------------
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Lap Length: ld/ld,min = 0.38756552
lb = 300.00
ld = 774.0627
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
   $\psi$ = 1
 db = 16.66667
 Mean strength value of all re-bars: fy = 524.4464
 Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
   t = 1.00
   s = 0.80
   e = 1.00
  cb = 25.00
 Ktr = 1.37392
  Atr = Min(Atr_x,Atr_y) = 257.6106
  where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
  s = Max(s_external,s_internal) = 250.00

n = 30.00
```

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

```

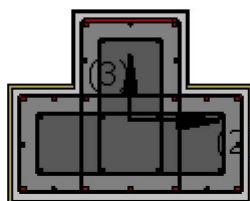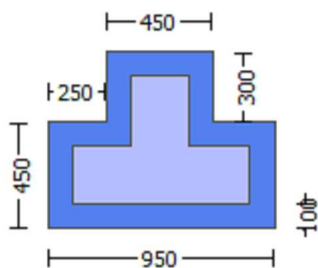```

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 JTC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcjtcs

Constant Properties
```
---------------------------------------------------------------
```
Knowledge Factor,   = 0.90
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 555.55
###
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.02437
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
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 = -0.00053663
EDGE -B-
Shear Force, Vb = 0.00053663
BOTH EDGES
Axial Force, F = -20792.011
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1539.38
      -Compression: Asl,com = 2475.575
         -Middle: Asl,mid = 2676.637

Calculation of Shear Capacity ratio , Ve/Vr = 0.56344875
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 624335.951
with
Mpr1 = Max(Mu1+ , Mu1-) = 9.3650E+008
   Mu1+ = 6.7320E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
   Mu1- = 9.3650E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 9.3650E+008
   Mu2+ = 6.7320E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
   Mu2- = 9.3650E+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 = 9.1136953E-006
Mu = 6.7320E+008

----

with full section properties:
  b = 950.00
  d = 707.00
  d' = 43.00
  ν = 0.00093808
    N = 20792.011
  fc = 33.00
   εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.01209008
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.01209008
      ωwe ((5.4c), TBDY) = ρse* ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.04611842
    where ωf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

      ωfx = 0.03444474
    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
    αf = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

      ωfy = 0.03444474
    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
    αf = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
      fu,f = 1055.00
      Ef = 64828.00
       εu,f = 0.015
      ρse ((5.4d), TBDY) = (ρse1*Aext+ρse2*Aint)/Asec = 0.53375773
        ρse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
               is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
        Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
               is calculated by reducing all the dimensions of the area Aconf,max1 by a length
               equal to half the clear spacing between external hoops.
        AnoConf1 = 173066.667 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
      ρse2 (>=ρse1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)

"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 110709.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 458.0986
fy1 = 381.7488
su1 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 381.7488
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 453.4475
fy2 = 377.8729
su2 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
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 = 377.8729

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00143155
  shv = 0.00458096
 ftv = 455.2307
 fyv = 379.359
  suv = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.31005242
     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 = 379.359
     with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.02651348
   2 = Asl,com/(b*d)*(fs2/fc) = 0.04220509
   v = Asl,mid/(b*d)*(fsv/fc) = 0.04581238
and confined core properties:
  b = 890.00
  d = 677.00
  d' = 13.00
 fcc (5A.2, TBDY) = 33.80412
   cc (5A.5, TBDY) = 0.00224367
     c = confinement factor = 1.02437
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.029555
   2 = Asl,com/(b*d)*(fs2/fc) = 0.0470467
   v = Asl,mid/(b*d)*(fsv/fc) = 0.0510678
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.14547789
Mu = MRc (4.14) = 6.7320E+008
  u =   su (4.1) = 9.1136953E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
    = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
    t = 1.00
    s = 0.80
    e = 1.00
  cb = 25.00
  Ktr = 1.37392
   Atr = Min(Atr_x,Atr_y) = 257.6106
   where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
   s = Max(s_external,s_internal) = 250.00
   n = 30.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 9.8526632E-006
Mu = 9.3650E+008

----

with full section properties:
  b = 450.00
  d = 707.00
  d' = 43.00
  v = 0.00198039
    N = 20792.011
  fc = 33.00
   εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.01209008
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.01209008
      ωwe ((5.4c), TBDY) = αse*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.04611842
    where ωf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

      ωfx = 0.03444474
    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
    αf = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A4.4.3(6), ρf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

      ωfy = 0.03444474
    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
    αf = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A4.4.3(6), ρf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

      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 = 0.53375773
        αse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
            is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
        Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
            is calculated by reducing all the dimensions of the area Aconf,max1 by a length
            equal to half the clear spacing between external hoops.
        AnoConf1 = 173066.667 is the unconfined external core area which is equal to Σbi2/6 as defined at (A.2).
      αse2 (>=αse1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
            is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
        Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
            is calculated by reducing all the dimensions of the area Aconf,max2 by a length

equal to half the clear spacing between internal hoops.

AnoConf2 = 110709.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).

psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578

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

----

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578

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

Lstir1 (Length of stirrups along Y) = 2160.00

Astir1 (stirrups area) = 78.53982

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

Lstir2 (Length of stirrups along Y) = 1568.00

Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307

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

Lstir1 (Length of stirrups along X) = 2560.00

Astir1 (stirrups area) = 78.53982

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

Lstir2 (Length of stirrups along X) = 1968.00

Astir2 (stirrups area) = 50.26548

Asec = 562500.00

s1 = 100.00

s2 = 250.00

fywe1 = 694.45

fywe2 = 555.55

fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00224367

c = confinement factor = 1.02437

y1 = 0.00143155

sh1 = 0.00458096

ft1 = 453.4475

fy1 = 377.8729

su1 = 0.00550601

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

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/ld = 0.31005242

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 = 377.8729

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

y2 = 0.00143155

sh2 = 0.00458096

ft2 = 458.0986

fy2 = 381.7488

su2 = 0.00550601

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242

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 = 381.7488

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

yv = 0.00143155

shv = 0.00458096

ftv = 455.2307

fyv = 379.359

suv = 0.00550601

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
 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 = 379.359
 with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.08909964
2 = Asl,com/(b*d)*(fs2/fc) = 0.05597289
v = Asl,mid/(b*d)*(fsv/fc) = 0.09671502
and confined core properties:
 b = 390.00
 d = 677.00
 d' = 13.00
 fcc (5A.2, TBDY) = 33.80412
  cc (5A.5, TBDY) = 0.00224367
    c = confinement factor = 1.02437
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.10736299
  2 = Asl,com/(b*d)*(fs2/fc) = 0.06744603
  v = Asl,mid/(b*d)*(fsv/fc) = 0.11653935
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.20956863
Mu = MRc (4.14) = 9.3650E+008
 u = su (4.1) = 9.8526632E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
    = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
    t = 1.00
    s = 0.80
    e = 1.00
  cb = 25.00
  Ktr = 1.37392
   Atr = Min(Atr_x,Atr_y) = 257.6106
   where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
   s = Max(s_external,s_internal) = 250.00
   n = 30.00

Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
 u = 9.1136953E-006
Mu = 6.7320E+008
----
with full section properties:

b = 950.00

d = 707.00

d' = 43.00

v = 0.00093808

  N = 20792.011

fc = 33.00

 co (5A.5, TBDY) = 0.002

Final value of cu: $cu^* = shear\_factor * Max(cu, cc) = 0.01209008$

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

   From (5.4b), TBDY: cu = 0.01209008

    we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.04611842

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

   ----

    fx = 0.03444474

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

   af = 0.28545185

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

    bmax = 950.00

    hmax = 750.00

    From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556

     bw = 450.00

    effective stress from (A.35), ff,e = 881.8461

   ----

    fy = 0.03444474

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

   af = 0.28545185

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

    bmax = 950.00

    hmax = 750.00

    From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556

     bw = 450.00

    effective stress from (A.35), ff,e = 881.8461

    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 = 0.53375773

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

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

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

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

     "Theoretical Stress-Strain Model for Confined Concrete."

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

     Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and

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

     Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and

       is calculated by reducing all the dimensions of the area Aconf,max1 by a length

       equal to half the clear spacing between external hoops.

     AnoConf1 = 173066.667 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).

    ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773

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

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

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

     "Theoretical Stress-Strain Model for Confined Concrete."

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

     Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and

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

     Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and

       is calculated by reducing all the dimensions of the area Aconf,max2 by a length

       equal to half the clear spacing between internal hoops.

     AnoConf2 = 110709.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).

    psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578

   Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without

earthquake detailing (90° closed stirrups)

```
        psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
           Lstir1 (Length of stirrups along Y) = 2160.00
           Astir1 (stirrups area) = 78.53982
        psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
           Lstir2 (Length of stirrups along Y) = 1568.00
           Astir2 (stirrups area) = 50.26548
     ------------------------------------------------------------------
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
           Lstir1 (Length of stirrups along X) = 2560.00
           Astir1 (stirrups area) = 78.53982
        psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
           Lstir2 (Length of stirrups along X) = 1968.00
           Astir2 (stirrups area) = 50.26548
     ------------------------------------------------------------------
        Asec = 562500.00
        s1 = 100.00
        s2 = 250.00
       fywe1 = 694.45
       fywe2 = 555.55
       fce  = 33.00
    From ((5.A5), TBDY), TBDY:  cc = 0.00224367
        c  = confinement factor = 1.02437
  y1 = 0.00143155
  sh1 = 0.00458096
 ft1 = 458.0986
 fy1 = 381.7488
  su1 = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.31005242
     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 = 381.7488
      with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.00143155
  sh2 = 0.00458096
 ft2 = 453.4475
 fy2 = 377.8729
  su2 = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
     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 = 377.8729
      with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00143155
  shv = 0.00458096
 ftv = 455.2307
 fyv = 379.359
  suv = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.31005242
     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 = 379.359
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.02651348
2 = Asl,com/(b*d)*(fs2/fc) = 0.04220509
v = Asl,mid/(b*d)*(fsv/fc) = 0.04581238
and confined core properties:
  b = 890.00
  d = 677.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.80412
  cc (5A.5, TBDY) = 0.00224367
     c = confinement factor = 1.02437
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.029555
     2 = Asl,com/(b*d)*(fs2/fc) = 0.0470467
     v = Asl,mid/(b*d)*(fsv/fc) = 0.0510678
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
  su (4.9) = 0.14547789
Mu = MRc (4.14) = 6.7320E+008
  u =   su (4.1) = 9.1136953E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
     = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
     t = 1.00
     s = 0.80
     e = 1.00
  cb = 25.00
  Ktr = 1.37392
   Atr = Min(Atr_x,Atr_y) = 257.6106
   where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
   s = Max(s_external,s_internal) = 250.00
   n = 30.00

Calculation of Mu2-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 9.8526632E-006
Mu = 9.3650E+008
----
with full section properties:
  b = 450.00
  d = 707.00
  d' = 43.00
  v = 0.00198039
     N = 20792.011
  fc = 33.00

co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01209008
  The Shear_factor is considered equal to 1 (pure moment strength)
  From (5.4b), TBDY: cu = 0.01209008
    we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx,   fy) = 0.04611842
  where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
  ----
    fx = 0.03444474
  Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
  af = 0.28545185
  with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
    bmax = 950.00
    hmax = 750.00
    From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
      bw = 450.00
    effective stress from (A.35), ff,e = 881.8461
  ----
    fy = 0.03444474
  Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
  af = 0.28545185
  with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
    bmax = 950.00
    hmax = 750.00
    From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
      bw = 450.00
    effective stress from (A.35), ff,e = 881.8461

    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 = 0.53375773
      ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
      The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
      of the rectangular sections confinement, which is expressed by (5.4d).
      The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
      "Theoretical Stress-Strain Model for Confined Concrete."
      J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
      Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
              is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
      Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
              is calculated by reducing all the dimensions of the area Aconf,max1 by a length
              equal to half the clear spacing between external hoops.
      AnoConf1 = 173066.667 is the unconfined external core area which is equal to   bi2/6 as defined at (A.2).
    ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
      The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
      of the rectangular sections confinement, which is expressed by (5.4d).
      The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
      "Theoretical Stress-Strain Model for Confined Concrete."
      J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
      Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
              is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
      Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
              is calculated by reducing all the dimensions of the area Aconf,max2 by a length
              equal to half the clear spacing between internal hoops.
      AnoConf2 = 110709.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
    psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
  Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
  ----
      psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
      psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
        Lstir1 (Length of stirrups along Y) = 2160.00
        Astir1 (stirrups area) = 78.53982
      psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
        Lstir2 (Length of stirrups along Y) = 1568.00

```
                Astir2 (stirrups area) = 50.26548
        ---------------------------------------------------------------
           psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
           psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
              Lstir1 (Length of stirrups along X) = 2560.00
              Astir1 (stirrups area) = 78.53982
           psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
              Lstir2 (Length of stirrups along X) = 1968.00
              Astir2 (stirrups area) = 50.26548
        ---------------------------------------------------------------
              Asec = 562500.00
               s1 = 100.00
               s2 = 250.00
            fywe1 = 694.45
            fywe2 = 555.55
             fce = 33.00
        From ((5.A5), TBDY), TBDY:  cc = 0.00224367
             c = confinement factor = 1.02437
     y1 = 0.00143155
    sh1 = 0.00458096
   ft1 = 453.4475
  fy1 = 377.8729
    su1 = 0.00550601
      using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
      and also multiplied by the shear_factor according to 15.7.1.4, with
      Shear_factor = 1.00
      lo/lou,min = lb/ld = 0.31005242
       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 = 377.8729
        with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
     y2 = 0.00143155
    sh2 = 0.00458096
   ft2 = 458.0986
  fy2 = 381.7488
    su2 = 0.00550601
      using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
       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 = 381.7488
        with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
     yv = 0.00143155
    shv = 0.00458096
   ftv = 455.2307
  fyv = 379.359
    suv = 0.00550601
      using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
      and also multiplied by the shear_factor according to 15.7.1.4, with
      Shear_factor = 1.00
      lo/lou,min = lb/ld = 0.31005242
       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 = 379.359
        with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
```

1 = Asl,ten/(b*d)*(fs1/fc) = 0.08909964
         2 = Asl,com/(b*d)*(fs2/fc) = 0.05597289
         v = Asl,mid/(b*d)*(fsv/fc) = 0.09671502
and confined core properties:
   b = 390.00
   d = 677.00
   d' = 13.00
   fcc (5A.2, TBDY) = 33.80412
     cc (5A.5, TBDY) = 0.00224367
        c = confinement factor = 1.02437
         1 = Asl,ten/(b*d)*(fs1/fc) = 0.10736299
         2 = Asl,com/(b*d)*(fs2/fc) = 0.06744603
         v = Asl,mid/(b*d)*(fsv/fc) = 0.11653935
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
  su (4.9) = 0.20956863
Mu = MRc (4.14) = 9.3650E+008
   u =   su (4.1) = 9.8526632E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
      = 1
   db = 16.66667
   Mean strength value of all re-bars: fy = 655.558
   Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
     t = 1.00
     s = 0.80
     e = 1.00
   cb = 25.00
   Ktr = 1.37392
     Atr = Min(Atr_x,Atr_y) = 257.6106
     where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
     s = Max(s_external,s_internal) = 250.00
     n = 30.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.1081E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.1081E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
   VCol0 = 1.1081E+006
   knl = 1 (zero step-static loading)

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

      = 1 (normal-weight concrete)
   Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
   M/Vd = 4.00
      Mu = 761.1315
      Vu = 0.00053663
   d = 0.8*h = 600.00
   Nu = 20792.011
   Ag = 337500.00
   From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 916401.511

where:
Vs,jacket = Vs,j1 + Vs,j2 = 837764.743
  Vs,j1 = 523602.964 is calculated for section web jacket, with:
    d = 600.00
    Av = 157079.633
    fy = 555.56
    s = 100.00
  Vs,j1 is multiplied by   Col,j1 = 1.00
    s/d = 0.16666667
  Vs,j2 = 314161.779 is calculated for section flange jacket, with:
    d = 360.00
    Av = 157079.633
    fy = 555.56
    s = 100.00
  Vs,j2 is multiplied by   Col,j2 = 1.00
    s/d = 0.27777778
 Vs,core = Vs,c1 + Vs,c2 = 78636.768
  Vs,c1 = 78636.768 is calculated for section web core, with:
    d = 440.00
    Av = 100530.965
    fy = 444.44
    s = 250.00
  Vs,c1 is multiplied by   Col,c1 = 1.00
    s/d = 0.56818182
  Vs,c2 = 0.00 is calculated for section flange core, with:
    d = 200.00
    Av = 100530.965
    fy = 444.44
    s = 250.00
  Vs,c2 is multiplied by   Col,c2 = 0.00
    s/d = 1.25
 Vf ((11-3)-(11.4), ACI 440) = 372533.843
   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) = 707.00
 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 < = 930841.148
    bw = 450.00

Calculation of Shear Strength at edge 2, Vr2 = 1.1081E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 1.1081E+006
  knl = 1 (zero step-static loading)

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

    = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 < = 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
    Mu = 761.1315
    Vu = 0.00053663
  d = 0.8*h = 600.00
  Nu = 20792.011
  Ag = 337500.00

From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 916401.511
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 837764.743
  Vs,j1 = 523602.964 is calculated for section web jacket, with:
    d = 600.00
    Av = 157079.633
    fy = 555.56
    s = 100.00
  Vs,j1 is multiplied by   Col,j1 = 1.00
    s/d = 0.16666667
  Vs,j2 = 314161.779 is calculated for section flange jacket, with:
    d = 360.00
    Av = 157079.633
    fy = 555.56
    s = 100.00
  Vs,j2 is multiplied by   Col,j2 = 1.00
    s/d = 0.27777778
  Vs,core = Vs,c1 + Vs,c2 = 78636.768
  Vs,c1 = 78636.768 is calculated for section web core, with:
    d = 440.00
    Av = 100530.965
    fy = 444.44
    s = 250.00
  Vs,c1 is multiplied by   Col,c1 = 1.00
    s/d = 0.56818182
  Vs,c2 = 0.00 is calculated for section flange core, with:
    d = 200.00
    Av = 100530.965
    fy = 444.44
    s = 250.00
  Vs,c2 is multiplied by   Col,c2 = 0.00
    s/d = 1.25
  Vf ((11-3)-(11.4), ACI 440) = 372533.843
    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) = 707.00
  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 < = 930841.148
    bw = 450.00

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

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

Constant Properties

Knowledge Factor,   = 0.90
Mean strength values are used for both shear and moment calculations.
Consequently:

Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 555.55
###
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.02437
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
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 = -4.4410684E-008
EDGE -B-
Shear Force, Vb = 4.4410684E-008
BOTH EDGES
Axial Force, F = -20792.011
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
    -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 1539.38
    -Compression: Asl,com = 1539.38
       -Middle: Asl,mid = 3612.832

Calculation of Shear Capacity ratio , Ve/Vr = 0.39733369

Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 646432.814
with
Mpr1 = Max(Mu1+ , Mu1-) = 9.6965E+008
  Mu1+ = 9.6965E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
  Mu1- = 9.6965E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 9.6965E+008
  Mu2+ = 9.6965E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
  Mu2- = 9.6965E+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 = 7.3807483E-006
Mu = 9.6965E+008
----
with full section properties:
  b = 450.00
  d = 907.00
  d' = 43.00
  v = 0.0015437
    N = 20792.011
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01209008
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.01209008
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.04611842
    where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----
      fx = 0.03444474
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461
    ----
      fy = 0.03444474
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

      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 = 0.53375773
        ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)

"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
      is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
      is calculated by reducing all the dimensions of the area Aconf,max1 by a length
      equal to half the clear spacing between external hoops.
AnoConf1 = 173066.667 is the unconfined external core area which is equal to $bi2/6$ as defined at (A.2).
ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
    The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
    of the rectangular sections confinement, which is expressed by (5.4d).
    The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
    "Theoretical Stress-Strain Model for Confined Concrete."
    J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
      is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
      is calculated by reducing all the dimensions of the area Aconf,max2 by a length
      equal to half the clear spacing between internal hoops.
AnoConf2 = 110709.333 is the unconfined internal core area which is equal to $bi2/6$ as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
  Lstir1 (Length of stirrups along Y) = 2160.00
  Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
  Lstir2 (Length of stirrups along Y) = 1568.00
  Astir2 (stirrups area) = 50.26548

----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
  Lstir1 (Length of stirrups along X) = 2560.00
  Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
  Lstir2 (Length of stirrups along X) = 1968.00
  Astir2 (stirrups area) = 50.26548

  Asec = 562500.00
  s1 = 100.00
  s2 = 250.00
  fywe1 = 694.45
  fywe2 = 555.55
  fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
  c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 458.0986
fy1 = 381.7488
su1 = 0.00550601
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.31005242
  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 = 381.7488
  with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 458.0986

fy2 = 381.7488
  su2 = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
      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 = 381.7488
      with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00143155
  shv = 0.00458096
 ftv = 452.7869
 fyv = 377.3224
  suv = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.31005242
      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 = 377.3224
      with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.04363047
    2 = Asl,com/(b*d)*(fs2/fc) = 0.04363047
    v = Asl,mid/(b*d)*(fsv/fc) = 0.10121073
and confined core properties:
  b = 390.00
  d = 877.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.80412
   cc (5A.5, TBDY) = 0.00224367
      c = confinement factor = 1.02437
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.05206495
    2 = Asl,com/(b*d)*(fs2/fc) = 0.05206495
    v = Asl,mid/(b*d)*(fsv/fc) = 0.12077642
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.17751206
Mu = MRc (4.14) = 9.6965E+008
  u =   su (4.1) = 7.3807483E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
    = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
    t = 1.00
    s = 0.80
    e = 1.00

cb = 25.00

Ktr = 1.37392

Atr = Min(Atr_x,Atr_y) = 257.6106

where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis

s = Max(s_external,s_internal) = 250.00

n = 30.00

Calculation of Mu1-

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

 ϕu = 7.3807483E-006

Mu = 9.6965E+008

----

with full section properties:

b = 450.00

d = 907.00

d' = 43.00

v = 0.0015437

N = 20792.011

fc = 33.00

ϵco (5A.5, TBDY) = 0.002

Final value of ϵcu: ϵcu^* = shear_factor * Max(ϵcu, ϵcc) = 0.01209008

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

From (5.4b), TBDY: ϵcu = 0.01209008

ωwe ((5.4c), TBDY) = $\alpha se^*\rho sh,min*fywe/fce+Min(\omega fx, \omega fy)$ = 0.04611842

where $\omega f = \alpha f*\rho f*ffe/fce$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.03444474

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

af = 0.28545185

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

bmax = 950.00

hmax = 750.00

From EC8 A4.4.3(6), pf = 2tf/bw = 0.00451556

bw = 450.00

effective stress from (A.35), ff,e = 881.8461

ωfy = 0.03444474

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

af = 0.28545185

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

bmax = 950.00

hmax = 750.00

From EC8 A4.4.3(6), pf = 2tf/bw = 0.00451556

bw = 450.00

effective stress from (A.35), ff,e = 881.8461

R = 40.00

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

fu,f = 1055.00

Ef = 64828.00

$\epsilon u,f$ = 0.015

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

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

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

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

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

"Theoretical Stress-Strain Model for Confined Concrete."

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

Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and

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

Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and

is calculated by reducing all the dimensions of the area Aconf,max1 by a length

equal to half the clear spacing between external hoops.
AnoConf1 = 173066.667 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 110709.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 458.0986
fy1 = 381.7488
su1 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 381.7488
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 458.0986
fy2 = 381.7488
su2 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242

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 = 381.7488
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00143155
shv = 0.00458096
ftv = 452.7869
fyv = 377.3224
suv = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 377.3224
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04363047
2 = Asl,com/(b*d)*(fs2/fc) = 0.04363047
v = Asl,mid/(b*d)*(fsv/fc) = 0.10121073
and confined core properties:
b = 390.00
d = 877.00
d' = 13.00
fcc (5A.2, TBDY) = 33.80412
cc (5A.5, TBDY) = 0.00224367
c = confinement factor = 1.02437
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05206495
2 = Asl,com/(b*d)*(fs2/fc) = 0.05206495
v = Asl,mid/(b*d)*(fsv/fc) = 0.12077642
Case/Assumption: Unconfinesd full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.17751206
Mu = MRc (4.14) = 9.6965E+008
u =   su (4.1) = 7.3807483E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 16.66667
Mean strength value of all re-bars: fy = 655.558
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
t = 1.00
s = 0.80
e = 1.00
cb = 25.00
Ktr = 1.37392
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 30.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 7.3807483E-006
Mu = 9.6965E+008
----
with full section properties:
  b = 450.00
  d = 907.00
  d' = 43.00
  v = 0.0015437
    N = 20792.011
  fc = 33.00
  εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.01209008
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.01209008
      ωwe ((5.4c), TBDY) = ρase*αsh,min*fywe/fce+Min(ωfx, ωfy) = 0.04611842
    where ωf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

      ωfx = 0.03444474
    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
    αf = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

      ωfy = 0.03444474
    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
    αf = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
      fu,f = 1055.00
      Ef = 64828.00
      εu,f = 0.015
      ρase ((5.4d), TBDY) = (ρase1*Aext+ρase2*Aint)/Asec = 0.53375773
        ρase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
                is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
        Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
                is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                equal to half the clear spacing between external hoops.
        AnoConf1 = 173066.667 is the unconfined external core area which is equal to Σbi2/6 as defined at (A.2).
      ρase2 (>=ρase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)

"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 110709.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548

----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 458.0986
fy1 = 381.7488
su1 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 381.7488
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 458.0986
fy2 = 381.7488
su2 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
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 = 381.7488

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00143155
  shv = 0.00458096
 ftv = 452.7869
 fyv = 377.3224
  suv = 0.00550601
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.31005242
    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 = 377.3224
   with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.04363047
 2 = Asl,com/(b*d)*(fs2/fc) = 0.04363047
 v = Asl,mid/(b*d)*(fsv/fc) = 0.10121073
and confined core properties:
 b = 390.00
 d = 877.00
 d' = 13.00
 fcc (5A.2, TBDY) = 33.80412
  cc (5A.5, TBDY) = 0.00224367
   c = confinement factor = 1.02437
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.05206495
  2 = Asl,com/(b*d)*(fs2/fc) = 0.05206495
  v = Asl,mid/(b*d)*(fsv/fc) = 0.12077642
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.17751206
Mu = MRc (4.14) = 9.6965E+008
 u =   su (4.1) = 7.3807483E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
   = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
   t = 1.00
   s = 0.80
   e = 1.00
  cb = 25.00
  Ktr = 1.37392
  Atr = Min(Atr_x,Atr_y) = 257.6106
  where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
  s = Max(s_external,s_internal) = 250.00
  n = 30.00

Calculation of Mu2-

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

  ϕu = 7.3807483E-006

Mu = 9.6965E+008

----

with full section properties:

  b = 450.00

  d = 907.00

  d' = 43.00

  v = 0.0015437

    N = 20792.011

  fc = 33.00

   ϵco (5A.5, TBDY) = 0.002

  Final value of ϵcu: ϵcu* = shear_factor * Max(ϵcu, ϵcc) = 0.01209008

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

     From (5.4b), TBDY: ϵcu = 0.01209008

       ωwe ((5.4c), TBDY) = αse* $\rho sh,min$*fywe/fce+Min(ϕfx, ϕfy) = 0.04611842

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

       ϕfx = 0.03444474

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

     af = 0.28545185

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

       bmax = 950.00

       hmax = 750.00

       From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556

         bw = 450.00

       effective stress from (A.35), ff,e = 881.8461

       ϕfy = 0.03444474

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

     af = 0.28545185

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

       bmax = 950.00

       hmax = 750.00

       From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556

         bw = 450.00

       effective stress from (A.35), ff,e = 881.8461

       R = 40.00

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

       fu,f = 1055.00

       Ef = 64828.00

        $\epsilon u,f$ = 0.015

       αse ((5.4d), TBDY) = ($\alpha se1$*Aext+$\alpha se2$*Aint)/Asec = 0.53375773

         $\alpha se1$ = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773

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

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

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

         "Theoretical Stress-Strain Model for Confined Concrete."

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

         Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and

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

         Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and

             is calculated by reducing all the dimensions of the area Aconf,max1 by a length

             equal to half the clear spacing between external hoops.

       AnoConf1 = 173066.667 is the unconfined external core area which is equal to   bi2/6 as defined at (A.2).

       $\alpha se2$ (>=$\alpha se1$) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773

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

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

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

         "Theoretical Stress-Strain Model for Confined Concrete."

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

         Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and

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

         Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and

             is calculated by reducing all the dimensions of the area Aconf,max2 by a length

equal to half the clear spacing between internal hoops.
AnoConf2 = 110709.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

----

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 458.0986
fy1 = 381.7488
su1 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 381.7488
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 458.0986
fy2 = 381.7488
su2 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
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 = 381.7488
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00143155
shv = 0.00458096
ftv = 452.7869
fyv = 377.3224
suv = 0.00550601

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
 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 = 377.3224
 with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.04363047
 2 = Asl,com/(b*d)*(fs2/fc) = 0.04363047
 v = Asl,mid/(b*d)*(fsv/fc) = 0.10121073
and confined core properties:
 b = 390.00
 d = 877.00
 d' = 13.00
 fcc (5A.2, TBDY) = 33.80412
 cc (5A.5, TBDY) = 0.00224367
 c = confinement factor = 1.02437
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.05206495
 2 = Asl,com/(b*d)*(fs2/fc) = 0.05206495
 v = Asl,mid/(b*d)*(fsv/fc) = 0.12077642
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.17751206
Mu = MRc (4.14) = 9.6965E+008
 u = su (4.1) = 7.3807483E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 = 1
 db = 16.66667
 Mean strength value of all re-bars: fy = 655.558
 Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
 t = 1.00
 s = 0.80
 e = 1.00
 cb = 25.00
 Ktr = 1.37392
 Atr = Min(Atr_x,Atr_y) = 257.6106
 where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
 s = Max(s_external,s_internal) = 250.00
 n = 30.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.6269E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.6269E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
 VCol0 = 1.6269E+006
 knl = 1 (zero step-static loading)

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

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

   = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
    Mu = 0.62237178
    Vu = 4.4410684E-008
  d = 0.8*h = 760.00
  Nu = 20792.011
  Ag = 427500.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 1.0846E+006
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 977392.20
  Vs,j1 = 314161.779 is calculated for section web jacket, with:
    d = 360.00
    Av = 157079.633
    fy = 555.56
    s = 100.00
  Vs,j1 is multiplied by Col,j1 = 1.00
    s/d = 0.27777778
  Vs,j2 = 663230.422 is calculated for section flange jacket, with:
    d = 760.00
    Av = 157079.633
    fy = 555.56
    s = 100.00
  Vs,j2 is multiplied by Col,j2 = 1.00
    s/d = 0.13157895
  Vs,core = Vs,c1 + Vs,c2 = 107231.957
  Vs,c1 = 0.00 is calculated for section web core, with:
    d = 200.00
    Av = 100530.965
    fy = 444.44
    s = 250.00
  Vs,c1 is multiplied by Col,c1 = 0.00
    s/d = 1.25
  Vs,c2 = 107231.957 is calculated for section flange core, with:
    d = 600.00
    Av = 100530.965
    fy = 444.44
    s = 250.00
  Vs,c2 is multiplied by Col,c2 = 1.00
    s/d = 0.41666667
  Vf ((11-3)-(11.4), ACI 440) = 477918.239
    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) = 907.00
  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 <= 1.1791E+006
    bw = 450.00

Calculation of Shear Strength at edge 2, Vr2 = 1.6269E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 1.6269E+006
  knl = 1 (zero step-static loading)

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

= 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 0.62124232
Vu = 4.4410684E-008
d = 0.8*h = 760.00
Nu = 20792.011
Ag = 427500.00
From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 1.0846E+006
where:
Vs,jacket = Vs,j1 + Vs,j2 = 977392.20
Vs,j1 = 314161.779 is calculated for section web jacket, with:
d = 360.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs,j1 is multiplied by Col,j1 = 1.00
s/d = 0.27777778
Vs,j2 = 663230.422 is calculated for section flange jacket, with:
d = 760.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs,j2 is multiplied by Col,j2 = 1.00
s/d = 0.13157895
Vs,core = Vs,c1 + Vs,c2 = 107231.957
Vs,c1 = 0.00 is calculated for section web core, with:
d = 200.00
Av = 100530.965
fy = 444.44
s = 250.00
Vs,c1 is multiplied by Col,c1 = 0.00
s/d = 1.25
Vs,c2 = 107231.957 is calculated for section flange core, with:
d = 600.00
Av = 100530.965
fy = 444.44
s = 250.00
Vs,c2 is multiplied by Col,c2 = 1.00
s/d = 0.41666667
Vf ((11-3)-(11.4), ACI 440) = 477918.239
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) = 907.00
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 <= 1.1791E+006
bw = 450.00

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

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

Constant Properties

Knowledge Factor,   = 0.90
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, $fc = fcm = 33.00$
New material of Secondary Member: Steel Strength, $fs = fsm = 555.56$
Concrete Elasticity, $Ec = 26999.444$
Steel Elasticity, $Es = 200000.00$
Existing Column
Existing material of Secondary Member: Concrete Strength, $fc = fcm = 20.00$
Existing material of Secondary Member: Steel Strength, $fs = fsm = 444.44$
Concrete Elasticity, $Ec = 21019.039$
Steel Elasticity, $Es = 200000.00$
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lb = 300.00
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 = 28326.959
Shear Force, V2 = -6880.904
Shear Force, V3 = -14.24369
Axial Force, F = -21249.44
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1539.38
     -Compression: Asl,com = 2475.575
        -Middle: Asl,mid = 2676.637
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,jacket = 1231.504
     -Compression: Asl,com,jacket = 1859.823
        -Middle: Asl,mid,jacket = 2060.885

Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
     -Tension: Asl,ten,core = 307.8761
    -Compression: Asl,com,core = 615.7522
     -Middle: Asl,mid,core = 615.7522
Mean Diameter of Tension Reinforcement, DbL = 16.57143

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity　θu,R = 　*　θu = 0.03970646
 θu = 　θy + 　θp = 0.04411829

 - Calculation of 　θy -

 θy = (My*Ls/3)/Eleff = 0.00211829 ((4.29),Biskinis Phd))
 My = 5.5411E+008
 Ls = M/V (with Ls > 0.1*L and Ls < 2*L) = 1988.737
 From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 1.7341E+014
   factor = 0.30
    Ag = 562500.00
    Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333
    N = 21249.44
   Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7803E+014

Calculation of Yielding Moment My

Calculation of 　ϕy and My according to Annex 7 　-

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

 ϕy = Min(ϕy_ten, ϕy_com)
 ϕy_ten = 3.1141730E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 352.1657
   d = 707.00
    ξy = 0.20024888
   A = 0.01005275
   B = 0.00471972
    with pt = 0.00229194
      pc = 0.00368581
      pv = 0.00398517
      N = 21249.44
      b = 950.00
       " = 0.06082037
 ϕy_comp = 1.5783869E-005
 with fc* (12.3, (ACI 440)) = 33.25688
   fc = 33.00
   fl = 0.43533893
   b = bmax = 950.00
   h = hmax = 750.00
   Ag = 0.5625
    ρg = pt + pc + pv = 0.00996292
   rc = 40.00
   Ae/Ac = 0.30198841
   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
  ξy = 0.19868555
  A = 0.00989157
  B = 0.00462988

with Es = 200000.00
CONFIRMATION: y = 0.19959754 < t/d

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.38756552
lb = 300.00
ld = 774.0627
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
     = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 524.4464
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
     t = 1.00
     s = 0.80
     e = 1.00
  cb = 25.00
  Ktr = 1.37392
   Atr = Min(Atr_x,Atr_y) = 257.6106
   where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
   s = Max(s_external,s_internal) = 250.00
   n = 30.00

 - 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 = 0.56344875
   d = d_external = 707.00
   s = s_external = 0.00
 -   t =   s1 +   s2 + 2*tf/bw*(ffe/fs) = 0.00568407
   jacket: s1 = Av1*Lstir1/(s1*Ag) = 0.00301593
        Av1 = 78.53982, is the area of every stirrup parallel to loading (shear) direction
        Lstir1 = 2160.00, is the total Length of all stirrups parallel to loading (shear) direction
        s1 = 100.00
   core: s2 = Av2*Lstir2/(s2*Ag) = 0.00056047
        Av2 = 50.26548, is the area of every stirrup parallel to loading (shear) direction
        Lstir2 = 1568.00, is the total Length of all stirrups parallel to loading (shear) direction
        s2 = 250.00
   The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
   where   f = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises   f to steel strength
   All these variables have already been given in Shear control ratio calculation.
   For the normalisation fs of jacket is used.
     NUD = 21249.44
     Ag = 562500.00
     f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 26.93333
     fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein =
529.9972
     fytE = (fy_ext_Trans_Reinf* s1+fy_int_Trans_Reinf* s2)/(s1+ s2) = 538.146
pl = Area_Tot_Long_Rein/(b*d) = 0.00996292
   b = 950.00
   d = 707.00
   f'cE = 26.93333

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

Calculation No. 11

column C1, Floor 1

Limit State: 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 JTC1 of floor 1
At local axis: 3
Integration Section: (a)
Section Type: rcjtcs

Constant Properties

Knowledge Factor,   = 0.90
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of y for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column

Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.44
##
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = lb = 300.00
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 = 28326.959
Shear Force, Va = -14.24369
EDGE -B-
Bending Moment, Mb = 15143.524
Shear Force, Vb = 14.24369
BOTH EDGES
Axial Force, F = -21249.44
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
      -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1539.38
      -Compression: Asl,com = 2475.575
         -Middle: Asl,mid = 2676.637
Mean Diameter of Tension Reinforcement, DbL,ten = 16.57143

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR =   *Vn = 905686.316
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 1.0063E+006
  VCol = 1.0063E+006
  knl = 1.00
     displacement_ductility_demand = 0.00475198

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 = 20.80, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
  M/Vd = 3.31456
     Mu = 28326.959
     Vu = 14.24369

d = 0.8*h = 600.00
Nu = 21249.44
Ag = 337500.00
From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 824756.036
where:
Vs,jacket = Vs,j1 + Vs,j2 = 753982.237
Vs,j1 = 471238.898 is calculated for section web jacket, with:
   d = 600.00
   Av = 157079.633
   fy = 500.00
   s = 100.00
Vs,j1 is multiplied by   Col,j1 = 1.00
   s/d = 0.16666667
Vs,j2 = 282743.339 is calculated for section flange jacket, with:
   d = 360.00
   Av = 157079.633
   fy = 500.00
   s = 100.00
Vs,j2 is multiplied by   Col,j2 = 1.00
   s/d = 0.27777778
Vs,core = Vs,c1 + Vs,c2 = 70773.799
Vs,c1 = 70773.799 is calculated for section web core, with:
   d = 440.00
   Av = 100530.965
   fy = 400.00
   s = 250.00
Vs,c1 is multiplied by   Col,c1 = 1.00
   s/d = 0.56818182
Vs,c2 = 0.00 is calculated for section flange core, with:
   d = 200.00
   Av = 100530.965
   fy = 400.00
   s = 250.00
Vs,c2 is multiplied by   Col,c2 = 0.00
   s/d = 1.25
Vf ((11-3)-(11.4), ACI 440) = 372533.843
   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) = 707.00
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 <= 818016.733
   bw = 450.00

----
displacement_ductility_demand is calculated as / y

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

From analysis, chord rotation   = 1.0066055E-005
 y = (My*Ls/3)/EIeff = 0.00211829 ((4.29),Biskinis Phd))
   My = 5.5411E+008
   Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1988.737
   From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7341E+014
      factor = 0.30
         Ag = 562500.00

Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333
 N = 21249.44
 Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7803E+014

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7 -

Assuming neutral axis within flange (y < t/d, compression zone rectangular) with:
flange width, b = 950.00
web width, bw = 450.00
flange thickness, t = 450.00
----
 y = Min(y_ten, y_com)
 y_ten = 3.1141730E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 352.1657
 d = 707.00
  y = 0.20024888
 A = 0.01005275
 B = 0.00471972
  with pt = 0.00229194
  pc = 0.00368581
  pv = 0.00398517
  N = 21249.44
  b = 950.00
   " = 0.06082037
 y_comp = 1.5783869E-005
 with fc* (12.3, (ACI 440)) = 33.25688
 fc = 33.00
 fl = 0.43533893
 b = bmax = 950.00
 h = hmax = 750.00
 Ag = 0.5625
  g = pt + pc + pv = 0.00996292
 rc = 40.00
 Ae/Ac = 0.30198841
 Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
 effective strain from (12.5) and (12.12), efe = 0.004
  fu = 0.01
 Ef = 64828.00
 Ec = 26999.444
  y = 0.19868555
 A = 0.00989157
 B = 0.00462988
  with Es = 200000.00
CONFIRMATION: y = 0.19959754 < t/d

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.38756552
lb = 300.00
ld = 774.0627
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 = 1
 db = 16.66667
 Mean strength value of all re-bars: fy = 524.4464
 Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
 t = 1.00
 s = 0.80
 e = 1.00
 cb = 25.00
 Ktr = 1.37392

Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 30.00

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

Calculation No. 12

column C1, Floor 1

Limit State: 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 JTC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcjtcs

Constant Properties

Knowledge Factor, = 0.90
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039

Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 555.55
##
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.02437
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
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 = -0.00053663
EDGE -B-
Shear Force, Vb = 0.00053663
BOTH EDGES
Axial Force, F = -20792.011
Longitudinal Reinforcement Area Distribution (in 2 divisions)
     -Tension: Aslt = 0.00
   -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
     -Tension: Asl,ten = 1539.38
   -Compression: Asl,com = 2475.575
     -Middle: Asl,mid = 2676.637

Calculation of Shear Capacity ratio , Ve/Vr = 0.56344875
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 624335.951
with
Mpr1 = Max(Mu1+ , Mu1-) = 9.3650E+008
   Mu1+ = 6.7320E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
   Mu1- = 9.3650E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 9.3650E+008

Mu2+ = 6.7320E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination

Mu2- = 9.3650E+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 = 9.1136953E-006
Mu = 6.7320E+008
----
with full section properties:
  b = 950.00
  d = 707.00
  d' = 43.00
  v = 0.00093808
    N = 20792.011
  fc = 33.00
  εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.01209008
      The Shear_factor is considered equal to 1 (pure moment strength)
      From (5.4b), TBDY: εcu = 0.01209008
        ωwe ((5.4c), TBDY) = ρase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.04611842
      where ωf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

        ωfx = 0.03444474
      Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
      αf = 0.28545185
      with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
        bmax = 950.00
        hmax = 750.00
        From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00451556
          bw = 450.00
        effective stress from (A.35), ff,e = 881.8461

        ωfy = 0.03444474
      Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
      αf = 0.28545185
      with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
        bmax = 950.00
        hmax = 750.00
        From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00451556
          bw = 450.00
        effective stress from (A.35), ff,e = 881.8461

        R = 40.00
        Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
        fu,f = 1055.00
        Ef = 64828.00
        εu,f = 0.015
        ρase ((5.4d), TBDY) = (ρase1*Aext+ρase2*Aint)/Asec = 0.53375773
          ρase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
          The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
          of the rectangular sections confinement, which is expressed by (5.4d).
          The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
          "Theoretical Stress-Strain Model for Confined Concrete."
          J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
          Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
                  is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
          Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
                  is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                  equal to half the clear spacing between external hoops.
          AnoConf1 = 173066.667 is the unconfined external core area which is equal to Σbi2/6 as defined at (A.2).
        ρase2 (>=ρase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773

The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 110709.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 458.0986
fy1 = 381.7488
su1 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 381.7488
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 453.4475
fy2 = 377.8729
su2 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
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 = 377.8729
   with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00143155
  shv = 0.00458096
 ftv = 455.2307
 fyv = 379.359
  suv = 0.00550601
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.31005242
    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 = 379.359
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.02651348
  2 = Asl,com/(b*d)*(fs2/fc) = 0.04220509
  v = Asl,mid/(b*d)*(fsv/fc) = 0.04581238
and confined core properties:
 b = 890.00
 d = 677.00
 d' = 13.00
 fcc (5A.2, TBDY) = 33.80412
  cc (5A.5, TBDY) = 0.00224367
   c = confinement factor = 1.02437
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.029555
  2 = Asl,com/(b*d)*(fs2/fc) = 0.0470467
  v = Asl,mid/(b*d)*(fsv/fc) = 0.0510678
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.14547789
Mu = MRc (4.14) = 6.7320E+008
 u =   su (4.1) = 9.1136953E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
   = 1
 db = 16.66667
 Mean strength value of all re-bars: fy = 655.558
 Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
   t = 1.00
   s = 0.80
   e = 1.00
 cb = 25.00
 Ktr = 1.37392
  Atr = Min(Atr_x,Atr_y) = 257.6106
  where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
  s = Max(s_external,s_internal) = 250.00
  n = 30.00

Calculation of Mu1-

Calculation of ultimate curvature ϕu according to 4.1, Biskinis/Fardis 2013:
  ϕu = 9.8526632E-006
Mu = 9.3650E+008
----
with full section properties:
  b = 450.00
  d = 707.00
  d' = 43.00
  v = 0.00198039
    N = 20792.011
  fc = 33.00
   εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu^* = shear_factor * Max(εcu, εcc) = 0.01209008
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: εcu = 0.01209008
       ωwe ((5.4c), TBDY) = αse^* $\rho sh,min^*$fywe/fce+Min(ϕfx, ϕfy) = 0.04611842
     where ϕf = $\alpha f^*\rho f^*$ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

       ϕfx = 0.03444474
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
       bmax = 950.00
       hmax = 750.00
       From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
         bw = 450.00
       effective stress from (A.35), ff,e = 881.8461

       ϕfy = 0.03444474
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
       bmax = 950.00
       hmax = 750.00
       From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
         bw = 450.00
       effective stress from (A.35), ff,e = 881.8461

       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
       αse ((5.4d), TBDY) = ($\alpha se1^*$Aext+$\alpha se2^*$Aint)/Asec = 0.53375773
         $\alpha se1$ = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
         The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
         of the rectangular sections confinement, which is expressed by (5.4d).
         The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
         "Theoretical Stress-Strain Model for Confined Concrete."
         J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
         Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
                 is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
         Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
                 is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                 equal to half the clear spacing between external hoops.
       AnoConf1 = 173066.667 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
         $\alpha se2$ (>=$\alpha se1$) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
         The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
         of the rectangular sections confinement, which is expressed by (5.4d).
         The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
         "Theoretical Stress-Strain Model for Confined Concrete."
         J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
         Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and

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

Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and

is calculated by reducing all the dimensions of the area Aconf,max2 by a length

equal to half the clear spacing between internal hoops.

AnoConf2 = 110709.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).

psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578

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

----

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578

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

Lstir1 (Length of stirrups along Y) = 2160.00

Astir1 (stirrups area) = 78.53982

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

Lstir2 (Length of stirrups along Y) = 1568.00

Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307

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

Lstir1 (Length of stirrups along X) = 2560.00

Astir1 (stirrups area) = 78.53982

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

Lstir2 (Length of stirrups along X) = 1968.00

Astir2 (stirrups area) = 50.26548

Asec = 562500.00

s1 = 100.00

s2 = 250.00

fywe1 = 694.45

fywe2 = 555.55

fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00224367

c = confinement factor = 1.02437

y1 = 0.00143155

sh1 = 0.00458096

ft1 = 453.4475

fy1 = 377.8729

su1 = 0.00550601

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

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/ld = 0.31005242

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 = 377.8729

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

y2 = 0.00143155

sh2 = 0.00458096

ft2 = 458.0986

fy2 = 381.7488

su2 = 0.00550601

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242

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 = 381.7488

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

yv = 0.00143155

shv = 0.00458096

ftv = 455.2307
fyv = 379.359
  suv = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.31005242
     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 = 379.359
     with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.08909964
  2 = Asl,com/(b*d)*(fs2/fc) = 0.05597289
  v = Asl,mid/(b*d)*(fsv/fc) = 0.09671502
and confined core properties:
  b = 390.00
  d = 677.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.80412
   cc (5A.5, TBDY) = 0.00224367
      c = confinement factor = 1.02437
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.10736299
    2 = Asl,com/(b*d)*(fs2/fc) = 0.06744603
    v = Asl,mid/(b*d)*(fsv/fc) = 0.11653935
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.20956863
Mu = MRc (4.14) = 9.3650E+008
  u =   su (4.1) = 9.8526632E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
     = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
     t = 1.00
     s = 0.80
     e = 1.00
  cb = 25.00
  Ktr = 1.37392
   Atr = Min(Atr_x,Atr_y) = 257.6106
   where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
   s = Max(s_external,s_internal) = 250.00
   n = 30.00

Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 9.1136953E-006

Mu = 6.7320E+008

----

with full section properties:
  b = 950.00
  d = 707.00
  d' = 43.00
  v = 0.00093808
    N = 20792.011
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: $cu^* = shear\_factor * Max(cu, cc) = 0.01209008$
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.01209008
      we ((5.4c), TBDY) = ase^* sh,min*fywe/fce+Min(fx, fy) = 0.04611842
    where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----
     fx = 0.03444474
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = $((bmax-2R)^2 + (hmax-2R)^2)/3 = 160566.667$
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461
    ----
     fy = 0.03444474
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = $((bmax-2R)^2 + (hmax-2R)^2)/3 = 160566.667$
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

    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 = 0.53375773
      ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
      The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
      of the rectangular sections confinement, which is expressed by (5.4d).
      The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
      "Theoretical Stress-Strain Model for Confined Concrete."
      J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
      Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
          is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
      Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
          is calculated by reducing all the dimensions of the area Aconf,max1 by a length
          equal to half the clear spacing between external hoops.
    AnoConf1 = 173066.667 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
    ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
      The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
      of the rectangular sections confinement, which is expressed by (5.4d).
      The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
      "Theoretical Stress-Strain Model for Confined Concrete."
      J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
      Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
          is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
      Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
          is calculated by reducing all the dimensions of the area Aconf,max2 by a length
          equal to half the clear spacing between internal hoops.
    AnoConf2 = 110709.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
    psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578

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

----
       psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
       psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
           Lstir1 (Length of stirrups along Y) = 2160.00
           Astir1 (stirrups area) = 78.53982
       psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
           Lstir2 (Length of stirrups along Y) = 1568.00
           Astir2 (stirrups area) = 50.26548

----
       psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
       psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
           Lstir1 (Length of stirrups along X) = 2560.00
           Astir1 (stirrups area) = 78.53982
       psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
           Lstir2 (Length of stirrups along X) = 1968.00
           Astir2 (stirrups area) = 50.26548

           Asec = 562500.00
           s1 = 100.00
           s2 = 250.00
       fywe1 = 694.45
       fywe2 = 555.55
       fce = 33.00
   From ((5.A5), TBDY), TBDY: cc = 0.00224367
         c = confinement factor = 1.02437
   y1 = 0.00143155
   sh1 = 0.00458096
 ft1 = 458.0986
 fy1 = 381.7488
  su1 = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.31005242
     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 = 381.7488
     with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
   y2 = 0.00143155
   sh2 = 0.00458096
 ft2 = 453.4475
 fy2 = 377.8729
  su2 = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
     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 = 377.8729
     with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
   yv = 0.00143155
   shv = 0.00458096
 ftv = 455.2307
 fyv = 379.359
  suv = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00

lo/lou,min = lb/ld = 0.31005242
  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 = 379.359
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.02651348
 2 = Asl,com/(b*d)*(fs2/fc) = 0.04220509
 v = Asl,mid/(b*d)*(fsv/fc) = 0.04581238
and confined core properties:
 b = 890.00
 d = 677.00
 d' = 13.00
 fcc (5A.2, TBDY) = 33.80412
  cc (5A.5, TBDY) = 0.00224367
   c = confinement factor = 1.02437
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.029555
  2 = Asl,com/(b*d)*(fs2/fc) = 0.0470467
  v = Asl,mid/(b*d)*(fsv/fc) = 0.0510678
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.14547789
Mu = MRc (4.14) = 6.7320E+008
 u = su (4.1) = 9.1136953E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
  = 1
 db = 16.66667
 Mean strength value of all re-bars: fy = 655.558
 Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  t = 1.00
  s = 0.80
  e = 1.00
 cb = 25.00
 Ktr = 1.37392
 Atr = Min(Atr_x,Atr_y) = 257.6106
 where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
 s = Max(s_external,s_internal) = 250.00
 n = 30.00

Calculation of Mu2-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 u = 9.8526632E-006
Mu = 9.3650E+008
----
with full section properties:
 b = 450.00
 d = 707.00
 d' = 43.00

v = 0.00198039
  N = 20792.011
fc = 33.00
  co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01209008
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.01209008
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.04611842
    where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----
    fx = 0.03444474
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461
----
    fy = 0.03444474
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

    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 = 0.53375773
      ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
      The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
      of the rectangular sections confinement, which is expressed by (5.4d).
      The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
      "Theoretical Stress-Strain Model for Confined Concrete."
      J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
      Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
          is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
      Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
          is calculated by reducing all the dimensions of the area Aconf,max1 by a length
          equal to half the clear spacing between external hoops.
      AnoConf1 = 173066.667 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
    ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
      The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
      of the rectangular sections confinement, which is expressed by (5.4d).
      The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
      "Theoretical Stress-Strain Model for Confined Concrete."
      J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
      Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
          is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
      Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
          is calculated by reducing all the dimensions of the area Aconf,max2 by a length
          equal to half the clear spacing between internal hoops.
      AnoConf2 = 110709.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
    psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
    Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
----
    psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
    psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
      Lstir1 (Length of stirrups along Y) = 2160.00

Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 453.4475
fy1 = 377.8729
su1 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 377.8729
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 458.0986
fy2 = 381.7488
su2 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
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 = 381.7488
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00143155
shv = 0.00458096
ftv = 455.2307
fyv = 379.359
suv = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 379.359
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.08909964
  2 = Asl,com/(b*d)*(fs2/fc) = 0.05597289
  v = Asl,mid/(b*d)*(fsv/fc) = 0.09671502
and confined core properties:
  b = 390.00
  d = 677.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.80412
   cc (5A.5, TBDY) = 0.00224367
    c = confinement factor = 1.02437
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.10736299
   2 = Asl,com/(b*d)*(fs2/fc) = 0.06744603
   v = Asl,mid/(b*d)*(fsv/fc) = 0.11653935
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.20956863
Mu = MRc (4.14) = 9.3650E+008
 u = su (4.1) = 9.8526632E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
   = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
   t = 1.00
   s = 0.80
   e = 1.00
  cb = 25.00
  Ktr = 1.37392
  Atr = Min(Atr_x,Atr_y) = 257.6106
   where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
  s = Max(s_external,s_internal) = 250.00
  n = 30.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.1081E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.1081E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 1.1081E+006
  knl = 1 (zero step-static loading)

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

   = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
   Mu = 761.1315
   Vu = 0.00053663
  d = 0.8*h = 600.00

Nu = 20792.011
Ag = 337500.00
From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 916401.511
where:
Vs,jacket = Vs,j1 + Vs,j2 = 837764.743
Vs,j1 = 523602.964 is calculated for section web jacket, with:
  d = 600.00
  Av = 157079.633
  fy = 555.56
  s = 100.00
Vs,j1 is multiplied by   Col,j1 = 1.00
  s/d = 0.16666667
Vs,j2 = 314161.779 is calculated for section flange jacket, with:
  d = 360.00
  Av = 157079.633
  fy = 555.56
  s = 100.00
Vs,j2 is multiplied by   Col,j2 = 1.00
  s/d = 0.27777778
Vs,core = Vs,c1 + Vs,c2 = 78636.768
Vs,c1 = 78636.768 is calculated for section web core, with:
  d = 440.00
  Av = 100530.965
  fy = 444.44
  s = 250.00
Vs,c1 is multiplied by   Col,c1 = 1.00
  s/d = 0.56818182
Vs,c2 = 0.00 is calculated for section flange core, with:
  d = 200.00
  Av = 100530.965
  fy = 444.44
  s = 250.00
Vs,c2 is multiplied by   Col,c2 = 0.00
  s/d = 1.25
Vf ((11-3)-(11.4), ACI 440) = 372533.843
  ψf = 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) = 707.00
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 <= 930841.148
  bw = 450.00

Calculation of Shear Strength at edge 2, Vr2 = 1.1081E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 1.1081E+006
  knl = 1 (zero step-static loading)

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

  = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 4.00
  Mu = 761.1315
  Vu = 0.00053663

d = 0.8*h = 600.00
Nu = 20792.011
Ag = 337500.00
From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 916401.511
where:
Vs,jacket = Vs,j1 + Vs,j2 = 837764.743
Vs,j1 = 523602.964 is calculated for section web jacket, with:
  d = 600.00
  Av = 157079.633
  fy = 555.56
  s = 100.00
Vs,j1 is multiplied by   Col,j1 = 1.00
  s/d = 0.16666667
Vs,j2 = 314161.779 is calculated for section flange jacket, with:
  d = 360.00
  Av = 157079.633
  fy = 555.56
  s = 100.00
Vs,j2 is multiplied by   Col,j2 = 1.00
  s/d = 0.27777778
Vs,core = Vs,c1 + Vs,c2 = 78636.768
Vs,c1 = 78636.768 is calculated for section web core, with:
  d = 440.00
  Av = 100530.965
  fy = 444.44
  s = 250.00
Vs,c1 is multiplied by   Col,c1 = 1.00
  s/d = 0.56818182
Vs,c2 = 0.00 is calculated for section flange core, with:
  d = 200.00
  Av = 100530.965
  fy = 444.44
  s = 250.00
Vs,c2 is multiplied by   Col,c2 = 0.00
  s/d = 1.25
Vf ((11-3)-(11.4), ACI 440) = 372533.843
  ϕf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sin α + cos α is replaced with (cot θ +cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ, α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45, α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 707.00
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 <= 930841.148
  bw = 450.00

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

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

Constant Properties

Knowledge Factor, = 0.90
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 555.55
##
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.02437
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
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 = -4.4410684E-008
EDGE -B-
Shear Force, Vb = 4.4410684E-008
BOTH EDGES
Axial Force, F = -20792.011
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
    -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 1539.38
    -Compression: Asl,com = 1539.38
        -Middle: Asl,mid = 3612.832

Calculation of Shear Capacity ratio , Ve/Vr = 0.39733369
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 646432.814
with
Mpr1 = Max(Mu1+ , Mu1-) = 9.6965E+008
  Mu1+ = 9.6965E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
  Mu1- = 9.6965E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 9.6965E+008
  Mu2+ = 9.6965E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
  Mu2- = 9.6965E+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 = 7.3807483E-006
Mu = 9.6965E+008
----
with full section properties:
  b = 450.00
  d = 907.00
  d' = 43.00
  v = 0.0015437
    N = 20792.011
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01209008
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.01209008
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+ Min(fx, fy) = 0.04611842
    where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----
      fx = 0.03444474
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A4.4.3(6), pf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461
    ----
      fy = 0.03444474
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A4.4.3(6), pf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

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

The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max1 by a length
equal to half the clear spacing between external hoops.
AnoConf1 = 173066.667 is the unconfined external core area which is equal to   bi2/6 as defined at (A.2).
ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 110709.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 458.0986
fy1 = 381.7488
su1 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 381.7488
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

```
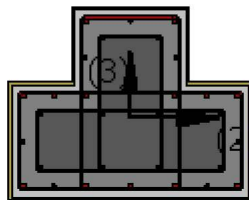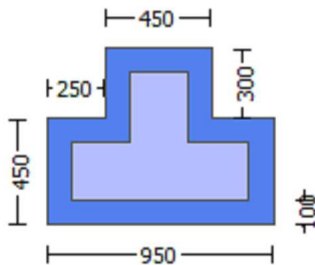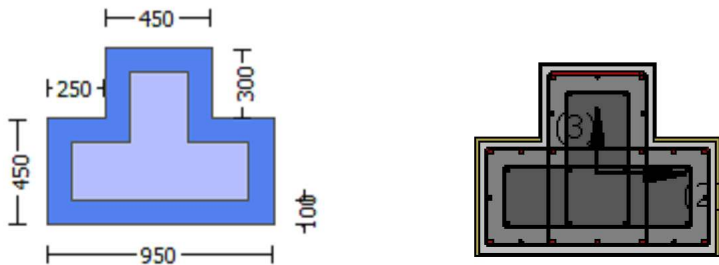    y2 = 0.00143155
    sh2 = 0.00458096
  ft2 = 458.0986
  fy2 = 381.7488
    su2 = 0.00550601
      using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
      and also multiplied by the shear_factor according to 15.7.1.4, with
      Shear_factor = 1.00
      lo/lou,min = lb/lb,min = 0.31005242
        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 = 381.7488
        with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
    yv = 0.00143155
    shv = 0.00458096
  ftv = 452.7869
  fyv = 377.3224
    suv = 0.00550601
      using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
      and also multiplied by the shear_factor according to 15.7.1.4, with
      Shear_factor = 1.00
      lo/lou,min = lb/ld = 0.31005242
        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 = 377.3224
        with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.04363047
    2 = Asl,com/(b*d)*(fs2/fc) = 0.04363047
    v = Asl,mid/(b*d)*(fsv/fc) = 0.10121073
and confined core properties:
  b = 390.00
  d = 877.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.80412
    cc (5A.5, TBDY) = 0.00224367
      c  = confinement factor = 1.02437
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.05206495
    2 = Asl,com/(b*d)*(fs2/fc) = 0.05206495
    v = Asl,mid/(b*d)*(fsv/fc) = 0.12077642
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.17751206
Mu = MRc (4.14) = 9.6965E+008
  u =   su (4.1) = 7.3807483E-006
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
     = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
```

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```
      t = 1.00
      s = 0.80
      e = 1.00
     cb = 25.00
    Ktr = 1.37392
     Atr = Min(Atr_x,Atr_y) = 257.6106
     where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
     s = Max(s_external,s_internal) = 250.00
     n = 30.00
```


Calculation of Mu1-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
   u = 7.3807483E-006
Mu = 9.6965E+008
----
with full section properties:
   b = 450.00
   d = 907.00
   d' = 43.00
   v = 0.0015437
     N = 20792.011
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01209008
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: cu = 0.01209008
       we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx,   fy) = 0.04611842
     where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
     ----
       fx = 0.03444474
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
        bmax = 950.00
        hmax = 750.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
          bw = 450.00
        effective stress from (A.35), ff,e = 881.8461
     ----
       fy = 0.03444474
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
        bmax = 950.00
        hmax = 750.00
        From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
          bw = 450.00
        effective stress from (A.35), ff,e = 881.8461

       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 = 0.53375773
          ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
          The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
          of the rectangular sections confinement, which is expressed by (5.4d).
          The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
          "Theoretical Stress-Strain Model for Confined Concrete."
          J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
          Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and

is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max1 by a length
equal to half the clear spacing between external hoops.
AnoConf1 = 173066.667 is the unconfined external core area which is equal to   bi2/6 as defined at (A.2).
ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 110709.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 458.0986
fy1 = 381.7488
su1 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 381.7488
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 458.0986
fy2 = 381.7488
su2 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
    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 = 381.7488
      with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00143155
  shv = 0.00458096
 ftv = 452.7869
 fyv = 377.3224
  suv = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.31005242
    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 = 377.3224
      with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.04363047
    2 = Asl,com/(b*d)*(fs2/fc) = 0.04363047
    v = Asl,mid/(b*d)*(fsv/fc) = 0.10121073
and confined core properties:
  b = 390.00
  d = 877.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.80412
   cc (5A.5, TBDY) = 0.00224367
      c = confinement factor = 1.02437
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.05206495
    2 = Asl,com/(b*d)*(fs2/fc) = 0.05206495
    v = Asl,mid/(b*d)*(fsv/fc) = 0.12077642
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.17751206
Mu = MRc (4.14) = 9.6965E+008
  u =   su (4.1) = 7.3807483E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
     = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
    t = 1.00
    s = 0.80
    e = 1.00
  cb = 25.00
  Ktr = 1.37392
   Atr = Min(Atr_x,Atr_y) = 257.6106

where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 30.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 7.3807483E-006
Mu = 9.6965E+008
----
with full section properties:
b = 450.00
d = 907.00
d' = 43.00
v = 0.0015437
N = 20792.011
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.01209008
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01209008
ωwe ((5.4c), TBDY) = αse*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.04611842
where ωf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.03444474
Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
af = 0.28545185
with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
bmax = 950.00
hmax = 750.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00451556
bw = 450.00
effective stress from (A.35), ff,e = 881.8461

ωfy = 0.03444474
Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
af = 0.28545185
with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
bmax = 950.00
hmax = 750.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00451556
bw = 450.00
effective stress from (A.35), ff,e = 881.8461

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 = 0.53375773
ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max1 by a length
equal to half the clear spacing between external hoops.
AnoConf1 = 173066.667 is the unconfined external core area which is equal to $\sum$bi2/6 as defined at (A.2).
ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773

The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 110709.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548

----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 458.0986
fy1 = 381.7488
su1 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 381.7488
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 458.0986
fy2 = 381.7488
su2 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
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 = 381.7488
  with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
 yv = 0.00143155
 shv = 0.00458096
ftv = 452.7869
fyv = 377.3224
 suv = 0.00550601
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.31005242
   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 = 377.3224
   with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.04363047
  2 = Asl,com/(b*d)*(fs2/fc) = 0.04363047
  v = Asl,mid/(b*d)*(fsv/fc) = 0.10121073
and confined core properties:
 b = 390.00
 d = 877.00
 d' = 13.00
 fcc (5A.2, TBDY) = 33.80412
  cc (5A.5, TBDY) = 0.00224367
   c = confinement factor = 1.02437
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.05206495
  2 = Asl,com/(b*d)*(fs2/fc) = 0.05206495
  v = Asl,mid/(b*d)*(fsv/fc) = 0.12077642
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.17751206
Mu = MRc (4.14) = 9.6965E+008
 u =   su (4.1) = 7.3807483E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
   = 1
 db = 16.66667
 Mean strength value of all re-bars: fy = 655.558
 Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
   t = 1.00
   s = 0.80
   e = 1.00
 cb = 25.00
 Ktr = 1.37392
  Atr = Min(Atr_x,Atr_y) = 257.6106
  where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
  s = Max(s_external,s_internal) = 250.00
  n = 30.00

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 7.3807483E-006
Mu = 9.6965E+008
----
with full section properties:
  b = 450.00
  d = 907.00
  d' = 43.00
  ν = 0.0015437
    N = 20792.011
  fc = 33.00
   εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.01209008
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.01209008
      ωwe ((5.4c), TBDY) = αse*ρsh,min*fywe/fce+Min(αfx, αfy) = 0.04611842
    where αf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

      αfx = 0.03444474
    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
    αf = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

      αfy = 0.03444474
    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
    αf = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

      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 = 0.53375773
        αse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
                is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
        Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
                is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                equal to half the clear spacing between external hoops.
        AnoConf1 = 173066.667 is the unconfined external core area which is equal to Σbi2/6 as defined at (A.2).
      αse2 (>=αse1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and

is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 110709.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 458.0986
fy1 = 381.7488
su1 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 381.7488
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 458.0986
fy2 = 381.7488
su2 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
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 = 381.7488
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00143155
shv = 0.00458096

ftv = 452.7869
fyv = 377.3224
  suv = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.31005242
     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 = 377.3224
     with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.04363047
  2 = Asl,com/(b*d)*(fs2/fc) = 0.04363047
  v = Asl,mid/(b*d)*(fsv/fc) = 0.10121073
and confined core properties:
  b = 390.00
  d = 877.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.80412
   cc (5A.5, TBDY) = 0.00224367
      c = confinement factor = 1.02437
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.05206495
    2 = Asl,com/(b*d)*(fs2/fc) = 0.05206495
    v = Asl,mid/(b*d)*(fsv/fc) = 0.12077642
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.17751206
Mu = MRc (4.14) = 9.6965E+008
 u =   su (4.1) = 7.3807483E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
    = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
    t = 1.00
    s = 0.80
    e = 1.00
  cb = 25.00
  Ktr = 1.37392
   Atr = Min(Atr_x,Atr_y) = 257.6106
   where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
   s = Max(s_external,s_internal) = 250.00
   n = 30.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.6269E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.6269E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 1.6269E+006

knl = 1 (zero step-static loading)

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

= 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
  Mu = 0.62237178
  Vu = 4.4410684E-008
d = 0.8*h = 760.00
Nu = 20792.011
Ag = 427500.00
From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 1.0846E+006
where:
Vs,jacket = Vs,j1 + Vs,j2 = 977392.20
 Vs,j1 = 314161.779 is calculated for section web jacket, with:
   d = 360.00
   Av = 157079.633
   fy = 555.56
   s = 100.00
 Vs,j1 is multiplied by Col,j1 = 1.00
   s/d = 0.27777778
 Vs,j2 = 663230.422 is calculated for section flange jacket, with:
   d = 760.00
   Av = 157079.633
   fy = 555.56
   s = 100.00
 Vs,j2 is multiplied by Col,j2 = 1.00
   s/d = 0.13157895
Vs,core = Vs,c1 + Vs,c2 = 107231.957
 Vs,c1 = 0.00 is calculated for section web core, with:
   d = 200.00
   Av = 100530.965
   fy = 444.44
   s = 250.00
 Vs,c1 is multiplied by Col,c1 = 0.00
   s/d = 1.25
 Vs,c2 = 107231.957 is calculated for section flange core, with:
   d = 600.00
   Av = 100530.965
   fy = 444.44
   s = 250.00
 Vs,c2 is multiplied by Col,c2 = 1.00
   s/d = 0.41666667
 Vf ((11-3)-(11.4), ACI 440) = 477918.239
   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) = 907.00
 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 <= 1.1791E+006
   bw = 450.00

Calculation of Shear Strength at edge 2, Vr2 = 1.6269E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0

```
  VCol0 = 1.6269E+006
  knl = 1 (zero step-static loading)
-------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
-------------------------------------------------------------
     = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
     Mu = 0.62124232
     Vu = 4.4410684E-008
  d = 0.8*h = 760.00
  Nu = 20792.011
  Ag = 427500.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 1.0846E+006
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 977392.20
  Vs,j1 = 314161.779 is calculated for section web jacket, with:
     d = 360.00
     Av = 157079.633
     fy = 555.56
     s = 100.00
  Vs,j1 is multiplied by  Col,j1 = 1.00
     s/d = 0.27777778
  Vs,j2 = 663230.422 is calculated for section flange jacket, with:
     d = 760.00
     Av = 157079.633
     fy = 555.56
     s = 100.00
  Vs,j2 is multiplied by  Col,j2 = 1.00
     s/d = 0.13157895
  Vs,core = Vs,c1 + Vs,c2 = 107231.957
  Vs,c1 = 0.00 is calculated for section web core, with:
     d = 200.00
     Av = 100530.965
     fy = 444.44
     s = 250.00
  Vs,c1 is multiplied by  Col,c1 = 0.00
     s/d = 1.25
  Vs,c2 = 107231.957 is calculated for section flange core, with:
     d = 600.00
     Av = 100530.965
     fy = 444.44
     s = 250.00
  Vs,c2 is multiplied by  Col,c2 = 1.00
     s/d = 0.41666667
  Vf ((11-3)-(11.4), ACI 440) = 477918.239
     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) = 907.00
  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 <= 1.1791E+006
     bw = 450.00
-------------------------------------------------------------
-------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column JTC1 of floor 1
```

At local axis: 2

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

Constant Properties

Knowledge Factor,   = 0.90
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lb = 300.00
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 = -2.0746E+007
Shear Force, V2 = -6880.904
Shear Force, V3 = -14.24369
Axial Force, F = -21249.44
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1539.38
     -Compression: Asl,com = 1539.38
        -Middle: Asl,mid = 3612.832
Longitudinal External Reinforcement Area Distribution (in 3 divisions)

-Tension: Asl,ten,jacket = 1231.504
-Compression: Asl,com,jacket = 1231.504
-Middle: Asl,mid,jacket = 2689.203
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,core = 307.8761
-Compression: Asl,com,core = 307.8761
-Middle: Asl,mid,core = 923.6282
Mean Diameter of Tension Reinforcement, DbL = 16.57143

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = * θu = 0.04042649
θu = θy + θp = 0.04491832

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00291832 ((4.29),Biskinis Phd))
My = 7.6198E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3014.959
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 2.6241E+014
factor = 0.30
Ag = 562500.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333
N = 21249.44
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 8.7468E+014

Calculation of Yielding Moment My

Calculation of θy and My according to Annex 7 -

θy = Min(θy_ten, θy_com)
θy_ten = 2.6145517E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 352.1657
d = 907.00
ξy = 0.2574726
A = 0.01654277
B = 0.00873394
with pt = 0.0037716
pc = 0.0037716
pv = 0.00885172
N = 21249.44
b = 450.00
" = 0.04740904
θy_comp = 9.5510798E-006
with fc* (12.3, (ACI 440)) = 33.253
fc = 33.00
fl = 0.43533893
b = bmax = 950.00
h = hmax = 750.00
Ag = 0.5625
ρg = pt + pc + pv = 0.01639493
rc = 40.00
Ae/Ac = 0.29742395
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
effective strain from (12.5) and (12.12), efe = 0.004
εfu = 0.01
Ef = 64828.00
Ec = 26999.444
ξy = 0.25591086
A = 0.01627751
B = 0.0085861
with Es = 200000.00

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.38756552
lb = 300.00
ld = 774.0627
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
  ψ = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 524.4464
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
    ψt = 1.00
    ψs = 0.80
    ψe = 1.00
  cb = 25.00
  Ktr = 1.37392
   Atr = Min(Atr_x,Atr_y) = 257.6106
   where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
   s = Max(s_external,s_internal) = 250.00
   n = 30.00

 - Calculation of ρ -

From table 10-8: ρ = 0.042
with:
 - Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
  shear control ratio VyE/VCol0E = 0.39733369
  d = d_external = 907.00
  s = s_external = 0.00
 - ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.00638555
  jacket: ρs1 = Av1*Lstir1/(s1*Ag) = 0.00357443
      Av1 = 78.53982, is the area of every stirrup parallel to loading (shear) direction
      Lstir1 = 2560.00, is the total Length of all stirrups parallel to loading (shear) direction
      s1 = 100.00
  core: ρs2 = Av2*Lstir2/(s2*Ag) = 0.00070345
      Av2 = 50.26548, is the area of every stirrup parallel to loading (shear) direction
      Lstir2 = 1968.00, is the total Length of all stirrups parallel to loading (shear) direction
      s2 = 250.00
  The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
  where ρf = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises ρf to steel strength
  All these variables have already been given in Shear control ratio calculation.
  For the normalisation fs of jacket is used.
   NUD = 21249.44
   Ag = 562500.00
   f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 26.93333
   fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein = 529.9972
   fytE = (fy_ext_Trans_Reinf* ρs1+fy_int_Trans_Reinf* ρs2)/(ρs1+ ρs2) = 537.2876
 ρl = Area_Tot_Long_Rein/(b*d) = 0.01639493
  b = 450.00
  d = 907.00
   f'cE = 26.93333

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

Calculation No. 13

column C1, Floor 1

Limit State: 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 JTC1 of floor 1
At local axis: 2
Integration Section: (b)
Section Type: rcjtcs

Constant Properties

Knowledge Factor,   = 0.90
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of y for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.44
##

Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = lb = 300.00
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 = -2.0746E+007
Shear Force, Va = -6880.904
EDGE -B-
Bending Moment, Mb = 98911.173
Shear Force, Vb = 6880.904
BOTH EDGES
Axial Force, F = -21249.44
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
    -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 1539.38
     -Compression: Asl,com = 1539.38
       -Middle: Asl,mid = 3612.832
Mean Diameter of Tension Reinforcement, DbL,ten = 16.57143

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR =   *Vn = 1.2873E+006
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 1.4303E+006
   VCol = 1.4303E+006
   knl = 1.00
      displacement_ductility_demand = 0.04120622

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 = 20.80, but fc^0.5 <= 8.3
MPa (22.5.3.1, ACI 318-14)
   M/Vd = 2.00
      Mu = 98911.173
      Vu = 6880.904
   d = 0.8*h = 760.00
   Nu = 21249.44
   Ag = 427500.00

From (11.5.4.8), ACI 318-14: $V_s = V_{s,jacket} + V_{s,core} = 976155.669$
  where:
 $V_{s,jacket} = V_{s,j1} + V_{s,j2} = 879645.943$
 $V_{s,j1} = 282743.339$ is calculated for section web jacket, with:
   $d = 360.00$
   $A_v = 157079.633$
   $f_y = 500.00$
   $s = 100.00$
 $V_{s,j1}$ is multiplied by $Co_{l,j1} = 1.00$
   $s/d = 0.27777778$
 $V_{s,j2} = 596902.604$ is calculated for section flange jacket, with:
   $d = 760.00$
   $A_v = 157079.633$
   $f_y = 500.00$
   $s = 100.00$
 $V_{s,j2}$ is multiplied by $Co_{l,j2} = 1.00$
   $s/d = 0.13157895$
 $V_{s,core} = V_{s,c1} + V_{s,c2} = 96509.726$
 $V_{s,c1} = 0.00$ is calculated for section web core, with:
   $d = 200.00$
   $A_v = 100530.965$
   $f_y = 400.00$
   $s = 250.00$
 $V_{s,c1}$ is multiplied by $Co_{l,c1} = 0.00$
   $s/d = 1.25$
 $V_{s,c2} = 96509.726$ is calculated for section flange core, with:
   $d = 600.00$
   $A_v = 100530.965$
   $f_y = 400.00$
   $s = 250.00$
 $V_{s,c2}$ is multiplied by $Co_{l,c2} = 1.00$
   $s/d = 0.41666667$
 V_f ((11-3)-(11.4), ACI 440) $= 477918.239$
  $\phi_f = 0.95$, for fully-wrapped sections
 $w_f/s_f = 1$ (FRP strips adjacent to one another).
 In (11.3) $\sin \alpha + \cos \alpha$ is replaced with $(\cot \theta + \cot \alpha)\sin \alpha$ which is more a generalised expression,
 where θ is the angle of the crack direction (see KANEPE).
 This later relation, considered as a function $V_f(\alpha, \theta)$, is implemented for every different fiber orientation a_i,
 as well as for 2 crack directions, $\theta = 45°$ and $\theta = -45°$ to take into consideration the cyclic seismic loading.
 orientation 1: $\alpha_1 = b_1 + 90° = 90.00$
 $V_f = Min(|V_f(45, \alpha_1)|, |V_f(-45, a_1)|)$, with:
 total thickness per orientation, $t_{f1} = NL*t/NoDir = 1.016$
 $d_{fv} = d$ (figure 11.2, ACI 440) $= 907.00$
 f_{fe} ((11-5), ACI 440) $= 259.312$
   $E_f = 64828.00$
   $\epsilon_{fe} = 0.004$, from (11.6a), ACI 440
    with $\epsilon_{fu} = 0.01$
 From (11-11), ACI 440: $V_s + V_f <= 1.0362E+006$
  $b_w = 450.00$

----
displacement_ductility_demand is calculated as μ / μ_y

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

From analysis, chord rotation $\theta = 1.1965642E\text{-}005$
 $\theta_y = (M_y*L_s/3)/EI_{eff} = 0.00029038$ ((4.29),Biskinis Phd))
 $M_y = 7.6198E+008$
 $L_s = M/V$ (with $L_s > 0.1*L$ and $L_s < 2*L$) $= 300.00$
 From table 10.5, ASCE 41_17: $EI_{eff} = factor*E_c*I_g = 2.6241E+014$
   $factor = 0.30$
    $A_g = 562500.00$
    Mean concrete strength: $f_c' = (f_c'\_jacket*Area\_jacket + f_c'\_core*Area\_core)/Area\_section = 26.93333$
    $N = 21249.44$
   $E_c*I_g = E_c\_jacket*I_g\_jacket + E_c\_core*I_g\_core = 8.7468E+014$

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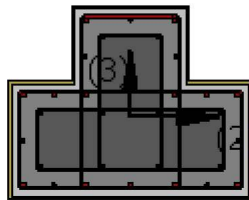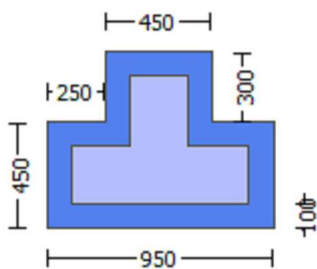------------------------------------------------------------
------------------------------------------------------------

Calculation of Yielding Moment My
------------------------------------------------------------
Calculation of  y and My according to Annex 7   -
------------------------------------------------------------
 y = Min( y_ten,  y_com)
 y_ten = 2.6145517E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 352.1657
    d = 907.00
     y = 0.2574726
    A = 0.01654277
    B = 0.00873394
     with pt = 0.0037716
         pc = 0.0037716
         pv = 0.00885172
         N = 21249.44
         b = 450.00
         " = 0.04740904
  y_comp = 9.5510798E-006
 with fc* (12.3, (ACI 440)) = 33.253
     fc = 33.00
     fl = 0.43533893
     b = bmax = 950.00
     h = hmax = 750.00
     Ag = 0.5625
        g = pt + pc + pv = 0.01639493
     rc = 40.00
     Ae/Ac = 0.29742395
     Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
    effective strain from (12.5) and (12.12), efe = 0.004
     fu = 0.01
    Ef = 64828.00
   Ec = 26999.444
    y = 0.25591086
   A = 0.01627751
   B = 0.0085861
    with Es = 200000.00
------------------------------------------------------------
------------------------------------------------------------


Calculation of ratio lb/ld
------------------------------------------------------------
Lap Length: ld/ld,min = 0.38756552
lb = 300.00
ld = 774.0627
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
    = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 524.4464
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
    t = 1.00
    s = 0.80
    e = 1.00
  cb = 25.00
  Ktr = 1.37392
   Atr = Min(Atr_x,Atr_y) = 257.6106
   where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
   s = Max(s_external,s_internal) = 250.00
   n = 30.00
------------------------------------------------------------
End Of Calculation of Shear Capacity for element: column JTC1 of floor 1
At local axis: 2
Integration Section: (b)
```

Calculation No. 14

column C1, Floor 1

Limit State: 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 JTC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcjtcs

Constant Properties

Knowledge Factor,   = 0.90
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 555.55
##

Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.02437
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
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 = -0.00053663
EDGE -B-
Shear Force, Vb = 0.00053663
BOTH EDGES
Axial Force, F = -20792.011
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
    -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 1539.38
    -Compression: Asl,com = 2475.575
      -Middle: Asl,mid = 2676.637

Calculation of Shear Capacity ratio , Ve/Vr = 0.56344875
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 624335.951
with
Mpr1 = Max(Mu1+ , Mu1-) = 9.3650E+008
   Mu1+ = 6.7320E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
   Mu1- = 9.3650E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 9.3650E+008
   Mu2+ = 6.7320E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
   Mu2- = 9.3650E+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 = 9.1136953E-006
Mu = 6.7320E+008
----
with full section properties:
  b = 950.00
  d = 707.00
  d' = 43.00
  v = 0.00093808
    N = 20792.011
  fc = 33.00
  εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.01209008
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.01209008
      ωwe ((5.4c), TBDY) = αse*ρsh,min*fywe/fce+Min(αfx, αfy) = 0.04611842
    where αf = af*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

      αfx = 0.03444474
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A 4.4.3(6), ρf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

      αfy = 0.03444474
    Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
    af = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A 4.4.3(6), ρf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

      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 = 0.53375773
        αse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
              is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
        Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
              is calculated by reducing all the dimensions of the area Aconf,max1 by a length
              equal to half the clear spacing between external hoops.
        AnoConf1 = 173066.667 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
      αse2 (>=αse1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
              is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
        Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
              is calculated by reducing all the dimensions of the area Aconf,max2 by a length

equal to half the clear spacing between internal hoops.

AnoConf2 = 110709.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).

psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578

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

----

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578

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

Lstir1 (Length of stirrups along Y) = 2160.00

Astir1 (stirrups area) = 78.53982

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

Lstir2 (Length of stirrups along Y) = 1568.00

Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307

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

Lstir1 (Length of stirrups along X) = 2560.00

Astir1 (stirrups area) = 78.53982

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

Lstir2 (Length of stirrups along X) = 1968.00

Astir2 (stirrups area) = 50.26548

Asec = 562500.00

s1 = 100.00

s2 = 250.00

fywe1 = 694.45

fywe2 = 555.55

fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00224367

c = confinement factor = 1.02437

y1 = 0.00143155

sh1 = 0.00458096

ft1 = 458.0986

fy1 = 381.7488

su1 = 0.00550601

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

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/ld = 0.31005242

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 = 381.7488

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

y2 = 0.00143155

sh2 = 0.00458096

ft2 = 453.4475

fy2 = 377.8729

su2 = 0.00550601

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242

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 = 377.8729

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

yv = 0.00143155

shv = 0.00458096

ftv = 455.2307

fyv = 379.359

suv = 0.00550601

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
  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 = 379.359
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.02651348
 2 = Asl,com/(b*d)*(fs2/fc) = 0.04220509
 v = Asl,mid/(b*d)*(fsv/fc) = 0.04581238
and confined core properties:
 b = 890.00
 d = 677.00
 d' = 13.00
 fcc (5A.2, TBDY) = 33.80412
  cc (5A.5, TBDY) = 0.00224367
    c = confinement factor = 1.02437
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.029555
  2 = Asl,com/(b*d)*(fs2/fc) = 0.0470467
  v = Asl,mid/(b*d)*(fsv/fc) = 0.0510678
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.14547789
Mu = MRc (4.14) = 6.7320E+008
 u = su (4.1) = 9.1136953E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
    = 1
 db = 16.66667
 Mean strength value of all re-bars: fy = 655.558
 Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
   t = 1.00
   s = 0.80
   e = 1.00
 cb = 25.00
 Ktr = 1.37392
  Atr = Min(Atr_x,Atr_y) = 257.6106
  where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
  s = Max(s_external,s_internal) = 250.00
  n = 30.00

Calculation of Mu1-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 u = 9.8526632E-006
Mu = 9.3650E+008
----
with full section properties:

b = 450.00
d = 707.00
d' = 43.00
v = 0.00198039
  N = 20792.011
fc = 33.00
  co (5A.5, TBDY) = 0.002
Final value of cu: $cu^* = shear\_factor * Max(cu, cc) = 0.01209008$
  The Shear_factor is considered equal to 1 (pure moment strength)
  From (5.4b), TBDY: cu = 0.01209008
    we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.04611842
  where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
  ----
    fx = 0.03444474
  Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
  af = 0.28545185
  with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
    bmax = 950.00
    hmax = 750.00
    From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
      bw = 450.00
    effective stress from (A.35), ff,e = 881.8461
  ----
    fy = 0.03444474
  Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
  af = 0.28545185
  with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
    bmax = 950.00
    hmax = 750.00
    From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
      bw = 450.00
    effective stress from (A.35), ff,e = 881.8461

    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 = 0.53375773
      ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
      The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
      of the rectangular sections confinement, which is expressed by (5.4d).
      The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
      "Theoretical Stress-Strain Model for Confined Concrete."
      J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
      Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
          is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
      Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
          is calculated by reducing all the dimensions of the area Aconf,max1 by a length
          equal to half the clear spacing between external hoops.
      AnoConf1 = 173066.667 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
    ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
      The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
      of the rectangular sections confinement, which is expressed by (5.4d).
      The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
      "Theoretical Stress-Strain Model for Confined Concrete."
      J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
      Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
          is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
      Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
          is calculated by reducing all the dimensions of the area Aconf,max2 by a length
          equal to half the clear spacing between internal hoops.
      AnoConf2 = 110709.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
      psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
  Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

```
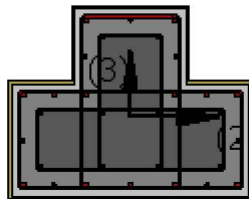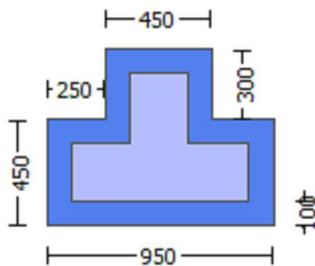        psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
            Lstir1 (Length of stirrups along Y) = 2160.00
            Astir1 (stirrups area) = 78.53982
        psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
            Lstir2 (Length of stirrups along Y) = 1568.00
            Astir2 (stirrups area) = 50.26548
      ---------------------------------------------------------------
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
            Lstir1 (Length of stirrups along X) = 2560.00
            Astir1 (stirrups area) = 78.53982
        psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
            Lstir2 (Length of stirrups along X) = 1968.00
            Astir2 (stirrups area) = 50.26548
      ---------------------------------------------------------------
        Asec = 562500.00
        s1 = 100.00
        s2 = 250.00
      fywe1 = 694.45
      fywe2 = 555.55
      fce  = 33.00
    From ((5.A5), TBDY), TBDY:  cc = 0.00224367
        c  = confinement factor = 1.02437
   y1 = 0.00143155
   sh1 = 0.00458096
  ft1 = 453.4475
  fy1 = 377.8729
   su1 = 0.00550601
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/ld = 0.31005242
      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 = 377.8729
       with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
   y2 = 0.00143155
   sh2 = 0.00458096
  ft2 = 458.0986
  fy2 = 381.7488
   su2 = 0.00550601
     using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
      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 = 381.7488
       with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
   yv = 0.00143155
   shv = 0.00458096
  ftv = 455.2307
  fyv = 379.359
   suv = 0.00550601
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/ld = 0.31005242
      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 = 379.359
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.08909964
2 = Asl,com/(b*d)*(fs2/fc) = 0.05597289
v = Asl,mid/(b*d)*(fsv/fc) = 0.09671502
and confined core properties:
b = 390.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 33.80412
cc (5A.5, TBDY) = 0.00224367
c = confinement factor = 1.02437
1 = Asl,ten/(b*d)*(fs1/fc) = 0.10736299
2 = Asl,com/(b*d)*(fs2/fc) = 0.06744603
v = Asl,mid/(b*d)*(fsv/fc) = 0.11653935
Case/Assumption: Unconfinesd full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.20956863
Mu = MRc (4.14) = 9.3650E+008
u =   su (4.1) = 9.8526632E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 16.66667
Mean strength value of all re-bars: fy = 655.558
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
t = 1.00
s = 0.80
e = 1.00
cb = 25.00
Ktr = 1.37392
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 30.00

Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
u = 9.1136953E-006
Mu = 6.7320E+008
----
with full section properties:
b = 950.00
d = 707.00
d' = 43.00
v = 0.00093808
N = 20792.011
fc = 33.00

co (5A.5, TBDY) = 0.002
  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01209008
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: cu = 0.01209008
      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+ Min(fx, fy) = 0.04611842
    where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
    ----
    fx = 0.03444474
  Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
  af = 0.28545185
  with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
    bmax = 950.00
    hmax = 750.00
    From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
      bw = 450.00
    effective stress from (A.35), ff,e = 881.8461
    ----
    fy = 0.03444474
  Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
  af = 0.28545185
  with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
    bmax = 950.00
    hmax = 750.00
    From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
      bw = 450.00
    effective stress from (A.35), ff,e = 881.8461

    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 = 0.53375773
      ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
      The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
      of the rectangular sections confinement, which is expressed by (5.4d).
      The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
      "Theoretical Stress-Strain Model for Confined Concrete."
      J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
      Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
              is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
      Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
              is calculated by reducing all the dimensions of the area Aconf,max1 by a length
              equal to half the clear spacing between external hoops.
      AnoConf1 = 173066.667 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
    ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
      The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
      of the rectangular sections confinement, which is expressed by (5.4d).
      The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
      "Theoretical Stress-Strain Model for Confined Concrete."
      J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
      Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
              is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
      Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
              is calculated by reducing all the dimensions of the area Aconf,max2 by a length
              equal to half the clear spacing between internal hoops.
      AnoConf2 = 110709.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
    psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
  Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

    ----
    psh_x*Fywe = psh1*Fywe1+ ps2*Fywe2 = 2.40578
    psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
      Lstir1 (Length of stirrups along Y) = 2160.00
      Astir1 (stirrups area) = 78.53982
    psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
      Lstir2 (Length of stirrups along Y) = 1568.00

```
            Astir2 (stirrups area) = 50.26548
      ------------------------------------------------------------------
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
          Lstir1 (Length of stirrups along X) = 2560.00
          Astir1 (stirrups area) = 78.53982
        psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
          Lstir2 (Length of stirrups along X) = 1968.00
          Astir2 (stirrups area) = 50.26548

      ------------------------------------------------------------------
          Asec = 562500.00
          s1 = 100.00
          s2 = 250.00
        fywe1 = 694.45
        fywe2 = 555.55
        fce = 33.00
      From ((5.A5), TBDY), TBDY:  cc = 0.00224367
          c = confinement factor = 1.02437
  y1 = 0.00143155
  sh1 = 0.00458096
 ft1 = 458.0986
 fy1 = 381.7488
  su1 = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.31005242
    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 = 381.7488
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.00143155
  sh2 = 0.00458096
 ft2 = 453.4475
 fy2 = 377.8729
  su2 = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
    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 = 377.8729
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00143155
  shv = 0.00458096
 ftv = 455.2307
 fyv = 379.359
  suv = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.31005242
    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 = 379.359
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
```

1 = Asl,ten/(b*d)*(fs1/fc) = 0.02651348
       2 = Asl,com/(b*d)*(fs2/fc) = 0.04220509
       v = Asl,mid/(b*d)*(fsv/fc) = 0.04581238
and confined core properties:
   b = 890.00
   d = 677.00
   d' = 13.00
   fcc (5A.2, TBDY) = 33.80412
     cc (5A.5, TBDY) = 0.00224367
        c = confinement factor = 1.02437
       1 = Asl,ten/(b*d)*(fs1/fc) = 0.029555
       2 = Asl,com/(b*d)*(fs2/fc) = 0.0470467
       v = Asl,mid/(b*d)*(fsv/fc) = 0.0510678
Case/Assumption: Unconfinesd full section - Steel rupture
   ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
   su (4.9) = 0.14547789
Mu = MRc (4.14) = 6.7320E+008
   u =   su (4.1) = 9.1136953E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
     = 1
   db = 16.66667
   Mean strength value of all re-bars: fy = 655.558
   Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
      t = 1.00
      s = 0.80
      e = 1.00
   cb = 25.00
   Ktr = 1.37392
     Atr = Min(Atr_x,Atr_y) = 257.6106
     where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
     s = Max(s_external,s_internal) = 250.00
     n = 30.00

Calculation of Mu2-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
   u = 9.8526632E-006
Mu = 9.3650E+008
----
with full section properties:
   b = 450.00
   d = 707.00
   d' = 43.00
   v = 0.00198039
      N = 20792.011
   fc = 33.00
    co (5A.5, TBDY) = 0.002
   Final value of   cu: cu* = shear_factor * Max(cu, cc) = 0.01209008
      The Shear_factor is considered equal to 1 (pure moment strength)
      From (5.4b), TBDY: cu = 0.01209008
        we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx,   fy) = 0.04611842
      where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

---
   fx = 0.03444474
Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
af = 0.28545185
with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
   bmax = 950.00
   hmax = 750.00
   From EC8 A 4.4.3(6), pf = 2tf/bw = 0.00451556
    bw = 450.00
   effective stress from (A.35), ff,e = 881.8461
---
   fy = 0.03444474
Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
af = 0.28545185
with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
   bmax = 950.00
   hmax = 750.00
   From EC8 A 4.4.3(6), pf = 2tf/bw = 0.00451556
    bw = 450.00
   effective stress from (A.35), ff,e = 881.8461

   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 = 0.53375773
    ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
    The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
    of the rectangular sections confinement, which is expressed by (5.4d).
    The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
    "Theoretical Stress-Strain Model for Confined Concrete."
    J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
    Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
       is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
    Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
       is calculated by reducing all the dimensions of the area Aconf,max1 by a length
       equal to half the clear spacing between external hoops.
    AnoConf1 = 173066.667 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
   ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
    The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
    of the rectangular sections confinement, which is expressed by (5.4d).
    The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
    "Theoretical Stress-Strain Model for Confined Concrete."
    J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
    Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
       is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
    Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
       is calculated by reducing all the dimensions of the area Aconf,max2 by a length
       equal to half the clear spacing between internal hoops.
    AnoConf2 = 110709.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
   psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
  Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
---
   psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
   psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
    Lstir1 (Length of stirrups along Y) = 2160.00
    Astir1 (stirrups area) = 78.53982
   psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
    Lstir2 (Length of stirrups along Y) = 1568.00
    Astir2 (stirrups area) = 50.26548
---
   psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
   psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
    Lstir1 (Length of stirrups along X) = 2560.00
    Astir1 (stirrups area) = 78.53982

psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
    Lstir2 (Length of stirrups along X) = 1968.00
    Astir2 (stirrups area) = 50.26548

    Asec = 562500.00
    s1 = 100.00
    s2 = 250.00
  fywe1 = 694.45
  fywe2 = 555.55
  fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
    c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 453.4475
fy1 = 377.8729
su1 = 0.00550601
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.31005242
  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 = 377.8729
  with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 458.0986
fy2 = 381.7488
su2 = 0.00550601
  using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
  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 = 381.7488
  with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00143155
shv = 0.00458096
ftv = 455.2307
fyv = 379.359
suv = 0.00550601
  using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
  and also multiplied by the shear_factor according to 15.7.1.4, with
  Shear_factor = 1.00
  lo/lou,min = lb/ld = 0.31005242
  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 = 379.359
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.08909964
  2 = Asl,com/(b*d)*(fs2/fc) = 0.05597289
  v = Asl,mid/(b*d)*(fsv/fc) = 0.09671502
and confined core properties:
b = 390.00
d = 677.00

d' = 13.00
   fcc (5A.2, TBDY) = 33.80412
    cc (5A.5, TBDY) = 0.00224367
       c = confinement factor = 1.02437
     1 = Asl,ten/(b*d)*(fs1/fc) = 0.10736299
     2 = Asl,com/(b*d)*(fs2/fc) = 0.06744603
     v = Asl,mid/(b*d)*(fsv/fc) = 0.11653935
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.20956863
Mu = MRc (4.14) = 9.3650E+008
 u =   su (4.1) = 9.8526632E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
    = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
     t = 1.00
     s = 0.80
     e = 1.00
  cb = 25.00
  Ktr = 1.37392
   Atr = Min(Atr_x,Atr_y) = 257.6106
   where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
   s = Max(s_external,s_internal) = 250.00
   n = 30.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.1081E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.1081E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 1.1081E+006
  knl = 1 (zero step-static loading)

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

    = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
     Mu = 761.1315
     Vu = 0.00053663
   d = 0.8*h = 600.00
   Nu = 20792.011
   Ag = 337500.00
   From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 916401.511
   where:
   Vs,jacket = Vs,j1 + Vs,j2 = 837764.743
   Vs,j1 = 523602.964 is calculated for section web jacket, with:
     d = 600.00
     Av = 157079.633
     fy = 555.56

```
        s = 100.00
    Vs,j1 is multiplied by   Col,j1 = 1.00
        s/d = 0.16666667
    Vs,j2 = 314161.779 is calculated for section flange jacket, with:
        d = 360.00
        Av = 157079.633
        fy = 555.56
        s = 100.00
    Vs,j2 is multiplied by   Col,j2 = 1.00
        s/d = 0.27777778
  Vs,core = Vs,c1 + Vs,c2 = 78636.768
    Vs,c1 = 78636.768 is calculated for section web core, with:
        d = 440.00
        Av = 100530.965
        fy = 444.44
        s = 250.00
    Vs,c1 is multiplied by   Col,c1 = 1.00
        s/d = 0.56818182
    Vs,c2 = 0.00 is calculated for section flange core, with:
        d = 200.00
        Av = 100530.965
        fy = 444.44
        s = 250.00
    Vs,c2 is multiplied by   Col,c2 = 0.00
        s/d = 1.25
    Vf ((11-3)-(11.4), ACI 440) = 372533.843
        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) = 707.00
    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 <= 930841.148
        bw = 450.00
-----------------------------------------------------------
------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 1.1081E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
    VCol0 = 1.1081E+006
    knl = 1 (zero step-static loading)
-----------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
-----------------------------------------------------------
    = 1 (normal-weight concrete)
    Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
    M/Vd = 4.00
        Mu = 761.1315
        Vu = 0.00053663
    d = 0.8*h = 600.00
    Nu = 20792.011
    Ag = 337500.00
    From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 916401.511
    where:
    Vs,jacket = Vs,j1 + Vs,j2 = 837764.743
    Vs,j1 = 523602.964 is calculated for section web jacket, with:
        d = 600.00
        Av = 157079.633
```

fy = 555.56
        s = 100.00
    Vs,j1 is multiplied by   Col,j1 = 1.00
        s/d = 0.16666667
    Vs,j2 = 314161.779 is calculated for section flange jacket, with:
        d = 360.00
        Av = 157079.633
        fy = 555.56
        s = 100.00
    Vs,j2 is multiplied by   Col,j2 = 1.00
        s/d = 0.27777778
   Vs,core = Vs,c1 + Vs,c2 = 78636.768
    Vs,c1 = 78636.768 is calculated for section web core, with:
        d = 440.00
        Av = 100530.965
        fy = 444.44
        s = 250.00
    Vs,c1 is multiplied by   Col,c1 = 1.00
        s/d = 0.56818182
    Vs,c2 = 0.00 is calculated for section flange core, with:
        d = 200.00
        Av = 100530.965
        fy = 444.44
        s = 250.00
    Vs,c2 is multiplied by   Col,c2 = 0.00
        s/d = 1.25
   Vf ((11-3)-(11.4), ACI 440) = 372533.843
      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) = 707.00
   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 <= 930841.148
       bw = 450.00

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

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

Constant Properties

Knowledge Factor,   = 0.90
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column

Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 555.55
##
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.02437
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
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 = -4.4410684E-008
EDGE -B-
Shear Force, Vb = 4.4410684E-008
BOTH EDGES
Axial Force, F = -20792.011
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1539.38
     -Compression: Asl,com = 1539.38
        -Middle: Asl,mid = 3612.832

Calculation of Shear Capacity ratio , Ve/Vr = 0.39733369
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 646432.814
with
Mpr1 = Max(Mu1+ , Mu1-) = 9.6965E+008
  Mu1+ = 9.6965E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination

Mu1- = 9.6965E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination

Mpr2 = Max(Mu2+ , Mu2-) = 9.6965E+008

Mu2+ = 9.6965E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination

Mu2- = 9.6965E+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 = 7.3807483E-006

Mu = 9.6965E+008

----

with full section properties:

b = 450.00

d = 907.00

d' = 43.00

ν = 0.0015437

N = 20792.011

fc = 33.00

εco (5A.5, TBDY) = 0.002

Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.01209008

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

From (5.4b), TBDY: εcu = 0.01209008

ωwe ((5.4c), TBDY) = αse* ρsh,min*fywe/fce+Min(εfx, εfy) = 0.04611842

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

εfx = 0.03444474

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

αf = 0.28545185

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

bmax = 950.00

hmax = 750.00

From EC8 A4.4.3(6), ρf = 2tf/bw = 0.00451556

bw = 450.00

effective stress from (A.35), ff,e = 881.8461

εfy = 0.03444474

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

αf = 0.28545185

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

bmax = 950.00

hmax = 750.00

From EC8 A4.4.3(6), ρf = 2tf/bw = 0.00451556

bw = 450.00

effective stress from (A.35), ff,e = 881.8461

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 = 0.53375773

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

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

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

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

"Theoretical Stress-Strain Model for Confined Concrete."

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

Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and

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

Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and

is calculated by reducing all the dimensions of the area Aconf,max1 by a length

equal to half the clear spacing between external hoops.

AnoConf1 = 173066.667 is the unconfined external core area which is equal to   bi2/6 as defined at (A.2).

ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773

The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.

Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.

Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.

AnoConf2 = 110709.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).

psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578

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

----

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00224367
c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 458.0986
fy1 = 381.7488
su1 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 381.7488
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 458.0986
fy2 = 381.7488
su2 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242

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 = 381.7488
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00143155
  shv = 0.00458096
 ftv = 452.7869
 fyv = 377.3224
  suv = 0.00550601
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.31005242
    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 = 377.3224
     with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.04363047
   2 = Asl,com/(b*d)*(fs2/fc) = 0.04363047
   v = Asl,mid/(b*d)*(fsv/fc) = 0.10121073
and confined core properties:
  b = 390.00
  d = 877.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.80412
   cc (5A.5, TBDY) = 0.00224367
     c = confinement factor = 1.02437
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.05206495
   2 = Asl,com/(b*d)*(fs2/fc) = 0.05206495
   v = Asl,mid/(b*d)*(fsv/fc) = 0.12077642
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.17751206
Mu = MRc (4.14) = 9.6965E+008
  u =   su (4.1) = 7.3807483E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
    = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
    t = 1.00
    s = 0.80
    e = 1.00
  cb = 25.00
  Ktr = 1.37392
   Atr = Min(Atr_x,Atr_y) = 257.6106
   where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
   s = Max(s_external,s_internal) = 250.00
   n = 30.00

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 7.3807483E-006
Mu = 9.6965E+008
----
with full section properties:
  b = 450.00
  d = 907.00
  d' = 43.00
  ν = 0.0015437
    N = 20792.011
  fc = 33.00
   εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.01209008
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.01209008
      ωwe ((5.4c), TBDY) = αse*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.04611842
    where ωf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

      ωfx = 0.03444474
    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
    αf = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

      ωfy = 0.03444474
    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
    αf = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

      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 = 0.53375773
        αse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
                is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
        Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
                is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                equal to half the clear spacing between external hoops.
        AnoConf1 = 173066.667 is the unconfined external core area which is equal to Σbi2/6 as defined at (A.2).
      αse2 (>=αse1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)

"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 110709.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548

----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 458.0986
fy1 = 381.7488
su1 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 381.7488
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 458.0986
fy2 = 381.7488
su2 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
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 = 381.7488

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
   yv = 0.00143155
   shv = 0.00458096
 ftv = 452.7869
 fyv = 377.3224
  suv = 0.00550601
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.31005242
    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 = 377.3224
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.04363047
  2 = Asl,com/(b*d)*(fs2/fc) = 0.04363047
  v = Asl,mid/(b*d)*(fsv/fc) = 0.10121073
and confined core properties:
  b = 390.00
  d = 877.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.80412
   cc (5A.5, TBDY) = 0.00224367
    c = confinement factor = 1.02437
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.05206495
   2 = Asl,com/(b*d)*(fs2/fc) = 0.05206495
   v = Asl,mid/(b*d)*(fsv/fc) = 0.12077642
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.17751206
Mu = MRc (4.14) = 9.6965E+008
 u = su (4.1) = 7.3807483E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
   = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
   t = 1.00
   s = 0.80
   e = 1.00
  cb = 25.00
  Ktr = 1.37392
  Atr = Min(Atr_x,Atr_y) = 257.6106
  where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
  s = Max(s_external,s_internal) = 250.00
  n = 30.00

Calculation of Mu2+

```
------------------------------------------------------------------------------------
Calculation of ultimate curvature  u according to 4.1, Biskinis/Fardis 2013:
  u = 7.3807483E-006
Mu = 9.6965E+008
------------------------------------------------------------------------------------
with full section properties:
  b = 450.00
  d = 907.00
  d' = 43.00
  v = 0.0015437
    N = 20792.011
  fc = 33.00
   co (5A.5, TBDY) = 0.002
  Final value of  cu:  cu* = shear_factor * Max( cu, cc) = 0.01209008
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY:  cu = 0.01209008
       we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min( fx,  fy) = 0.04611842
     where   f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
     ------------------------------------------------------------------
       fx = 0.03444474
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
        bmax = 950.00
        hmax = 750.00
        From EC8 A4.4.3(6), pf = 2tf/bw = 0.00451556
           bw = 450.00
        effective stress from (A.35), ff,e = 881.8461
     ------------------------------------------------------------------
       fy = 0.03444474
     Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
     af = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
        bmax = 950.00
        hmax = 750.00
        From EC8 A4.4.3(6), pf = 2tf/bw = 0.00451556
           bw = 450.00
        effective stress from (A.35), ff,e = 881.8461
     ------------------------------------------------------------------
        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 = 0.53375773
           ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
           The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
           of the rectangular sections confinement, which is expressed by (5.4d).
           The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
           "Theoretical Stress-Strain Model for Confined Concrete."
           J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
           Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
                   is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
           Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
                   is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                   equal to half the clear spacing between external hoops.
           AnoConf1 = 173066.667 is the unconfined external core area which is equal to  bi2/6 as defined at (A.2).
        ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
           The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
           of the rectangular sections confinement, which is expressed by (5.4d).
           The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
           "Theoretical Stress-Strain Model for Confined Concrete."
           J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
           Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
                   is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
           Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
                   is calculated by reducing all the dimensions of the area Aconf,max2 by a length
```

equal to half the clear spacing between internal hoops.

AnoConf2 = 110709.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).

psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578

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

----

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578

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

Lstir1 (Length of stirrups along Y) = 2160.00

Astir1 (stirrups area) = 78.53982

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

Lstir2 (Length of stirrups along Y) = 1568.00

Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307

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

Lstir1 (Length of stirrups along X) = 2560.00

Astir1 (stirrups area) = 78.53982

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

Lstir2 (Length of stirrups along X) = 1968.00

Astir2 (stirrups area) = 50.26548

Asec = 562500.00

s1 = 100.00

s2 = 250.00

fywe1 = 694.45

fywe2 = 555.55

fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00224367

c = confinement factor = 1.02437

y1 = 0.00143155

sh1 = 0.00458096

ft1 = 458.0986

fy1 = 381.7488

su1 = 0.00550601

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

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/ld = 0.31005242

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 = 381.7488

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

y2 = 0.00143155

sh2 = 0.00458096

ft2 = 458.0986

fy2 = 381.7488

su2 = 0.00550601

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242

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 = 381.7488

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

yv = 0.00143155

shv = 0.00458096

ftv = 452.7869

fyv = 377.3224

suv = 0.00550601

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
 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 = 377.3224
 with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.04363047
 2 = Asl,com/(b*d)*(fs2/fc) = 0.04363047
 v = Asl,mid/(b*d)*(fsv/fc) = 0.10121073
and confined core properties:
 b = 390.00
 d = 877.00
 d' = 13.00
 fcc (5A.2, TBDY) = 33.80412
  cc (5A.5, TBDY) = 0.00224367
    c = confinement factor = 1.02437
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.05206495
 2 = Asl,com/(b*d)*(fs2/fc) = 0.05206495
 v = Asl,mid/(b*d)*(fsv/fc) = 0.12077642
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.17751206
Mu = MRc (4.14) = 9.6965E+008
  u =   su (4.1) = 7.3807483E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
    = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
    t = 1.00
    s = 0.80
    e = 1.00
  cb = 25.00
  Ktr = 1.37392
   Atr = Min(Atr_x,Atr_y) = 257.6106
   where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
   s = Max(s_external,s_internal) = 250.00
   n = 30.00

Calculation of Mu2-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 7.3807483E-006
Mu = 9.6965E+008
----
with full section properties:

b = 450.00
d = 907.00
d' = 43.00
v = 0.0015437
   N = 20792.011
fc = 33.00
  co (5A.5, TBDY) = 0.002
Final value of cu: $cu^* = shear\_factor * Max(cu, cc) = 0.01209008$
   The Shear_factor is considered equal to 1 (pure moment strength)
   From (5.4b), TBDY: cu = 0.01209008
     we ((5.4c), TBDY) = $ase^* sh,min*fywe/fce + Min(fx, fy) = 0.04611842$
   where f = $af*pf*ffe/fce$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
   ----
    fx = 0.03444474
   Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
   af = 0.28545185
   with Unconfined area = $((bmax-2R)^2 + (hmax-2R)^2)/3 = 160566.667$
     bmax = 950.00
     hmax = 750.00
     From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
      bw = 450.00
     effective stress from (A.35), ff,e = 881.8461
   ----
    fy = 0.03444474
   Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
   af = 0.28545185
   with Unconfined area = $((bmax-2R)^2 + (hmax-2R)^2)/3 = 160566.667$
     bmax = 950.00
     hmax = 750.00
     From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
      bw = 450.00
     effective stress from (A.35), ff,e = 881.8461

    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 = 0.53375773
     ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
     The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
     of the rectangular sections confinement, which is expressed by (5.4d).
     The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
     "Theoretical Stress-Strain Model for Confined Concrete."
     J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
     Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
        is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
     Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
        is calculated by reducing all the dimensions of the area Aconf,max1 by a length
        equal to half the clear spacing between external hoops.
    AnoConf1 = 173066.667 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
    ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
     The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
     of the rectangular sections confinement, which is expressed by (5.4d).
     The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
     "Theoretical Stress-Strain Model for Confined Concrete."
     J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
     Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
        is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
     Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
        is calculated by reducing all the dimensions of the area Aconf,max2 by a length
        equal to half the clear spacing between internal hoops.
    AnoConf2 = 110709.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
    psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
   Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

```
        psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
            Lstir1 (Length of stirrups along Y) = 2160.00
            Astir1 (stirrups area) = 78.53982
        psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
            Lstir2 (Length of stirrups along Y) = 1568.00
            Astir2 (stirrups area) = 50.26548
    --------------------------------------------------------------------
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
            Lstir1 (Length of stirrups along X) = 2560.00
            Astir1 (stirrups area) = 78.53982
        psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
            Lstir2 (Length of stirrups along X) = 1968.00
            Astir2 (stirrups area) = 50.26548
    --------------------------------------------------------------------
        Asec = 562500.00
        s1 = 100.00
        s2 = 250.00
      fywe1 = 694.45
      fywe2 = 555.55
      fce  = 33.00
   From ((5.A5), TBDY), TBDY:  cc = 0.00224367
        c  = confinement factor = 1.02437
  y1 = 0.00143155
 sh1 = 0.00458096
ft1 = 458.0986
fy1 = 381.7488
 su1 = 0.00550601
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.31005242
    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 = 381.7488
     with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.00143155
 sh2 = 0.00458096
ft2 = 458.0986
fy2 = 381.7488
 su2 = 0.00550601
   using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
    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 = 381.7488
     with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00143155
 shv = 0.00458096
ftv = 452.7869
fyv = 377.3224
 suv = 0.00550601
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.31005242
    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 = 377.3224
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.04363047
 2 = Asl,com/(b*d)*(fs2/fc) = 0.04363047
 v = Asl,mid/(b*d)*(fsv/fc) = 0.10121073
and confined core properties:
 b = 390.00
 d = 877.00
 d' = 13.00
 fcc (5A.2, TBDY) = 33.80412
  cc (5A.5, TBDY) = 0.00224367
   c = confinement factor = 1.02437
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.05206495
 2 = Asl,com/(b*d)*(fs2/fc) = 0.05206495
 v = Asl,mid/(b*d)*(fsv/fc) = 0.12077642
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.17751206
Mu = MRc (4.14) = 9.6965E+008
 u =   su (4.1) = 7.3807483E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
   = 1
 db = 16.66667
 Mean strength value of all re-bars: fy = 655.558
 Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
   t = 1.00
   s = 0.80
   e = 1.00
 cb = 25.00
 Ktr = 1.37392
  Atr = Min(Atr_x,Atr_y) = 257.6106
  where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
  s = Max(s_external,s_internal) = 250.00
  n = 30.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.6269E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.6269E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
 VCol0 = 1.6269E+006
 knl = 1 (zero step-static loading)

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

   = 1 (normal-weight concrete)
 Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
 M/Vd = 2.00

```
     Mu = 0.62237178
     Vu = 4.4410684E-008
   d = 0.8*h = 760.00
   Nu = 20792.011
   Ag = 427500.00
   From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 1.0846E+006
   where:
  Vs,jacket = Vs,j1 + Vs,j2 = 977392.20
  Vs,j1 = 314161.779 is calculated for section web jacket, with:
     d = 360.00
     Av = 157079.633
     fy = 555.56
     s = 100.00
  Vs,j1 is multiplied by   Col,j1 = 1.00
     s/d = 0.27777778
  Vs,j2 = 663230.422 is calculated for section flange jacket, with:
     d = 760.00
     Av = 157079.633
     fy = 555.56
     s = 100.00
  Vs,j2 is multiplied by   Col,j2 = 1.00
     s/d = 0.13157895
  Vs,core = Vs,c1 + Vs,c2 = 107231.957
  Vs,c1 = 0.00 is calculated for section web core, with:
     d = 200.00
     Av = 100530.965
     fy = 444.44
     s = 250.00
  Vs,c1 is multiplied by   Col,c1 = 0.00
     s/d = 1.25
  Vs,c2 = 107231.957 is calculated for section flange core, with:
     d = 600.00
     Av = 100530.965
     fy = 444.44
     s = 250.00
  Vs,c2 is multiplied by   Col,c2 = 1.00
     s/d = 0.41666667
  Vf ((11-3)-(11.4), ACI 440) = 477918.239
     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) = 907.00
  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 <= 1.1791E+006
     bw = 450.00
-----------------------------------------------------------------
-----------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 1.6269E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 1.6269E+006
  knl = 1 (zero step-static loading)
-----------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+  f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
-----------------------------------------------------------------
    = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
```

M/Vd = 2.00
  Mu = 0.62124232
  Vu = 4.4410684E-008
d = 0.8*h = 760.00
Nu = 20792.011
Ag = 427500.00
From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 1.0846E+006
 where:
Vs,jacket = Vs,j1 + Vs,j2 = 977392.20
Vs,j1 = 314161.779 is calculated for section web jacket, with:
  d = 360.00
  Av = 157079.633
  fy = 555.56
  s = 100.00
Vs,j1 is multiplied by   Col,j1 = 1.00
  s/d = 0.27777778
Vs,j2 = 663230.422 is calculated for section flange jacket, with:
  d = 760.00
  Av = 157079.633
  fy = 555.56
  s = 100.00
Vs,j2 is multiplied by   Col,j2 = 1.00
  s/d = 0.13157895
Vs,core = Vs,c1 + Vs,c2 = 107231.957
Vs,c1 = 0.00 is calculated for section web core, with:
  d = 200.00
  Av = 100530.965
  fy = 444.44
  s = 250.00
Vs,c1 is multiplied by   Col,c1 = 0.00
  s/d = 1.25
Vs,c2 = 107231.957 is calculated for section flange core, with:
  d = 600.00
  Av = 100530.965
  fy = 444.44
  s = 250.00
Vs,c2 is multiplied by   Col,c2 = 1.00
  s/d = 0.41666667
Vf ((11-3)-(11.4), ACI 440) = 477918.239
  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) = 907.00
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 <= 1.1791E+006
  bw = 450.00

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

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

Constant Properties

Knowledge Factor,   = 0.90
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lb = 300.00
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 = 15143.524
Shear Force, V2 = 6880.904
Shear Force, V3 = 14.24369
Axial Force, F = -21249.44
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
      -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1539.38
      -Compression: Asl,com = 2475.575
         -Middle: Asl,mid = 2676.637
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,jacket = 1231.504
      -Compression: Asl,com,jacket = 1859.823
         -Middle: Asl,mid,jacket = 2060.885
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,core = 307.8761
      -Compression: Asl,com,core = 615.7522
         -Middle: Asl,mid,core = 615.7522
Mean Diameter of Tension Reinforcement, DbL = 16.57143

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = α * θu = 0.03881919
θu = θy + θp = 0.04313243

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00113243 ((4.29),Biskinis Phd))
My = 5.5411E+008
Ls = M/V (with Ls > 0.1*L and Ls < 2*L) = 1063.174
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7341E+014
   factor = 0.30
      Ag = 562500.00
      Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333
      N = 21249.44
   Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7803E+014

Calculation of Yielding Moment My

Calculation of θy and My according to Annex 7   -

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

ξy = Min(ξy_ten, ξy_com)
ξy_ten = 3.1141730E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 352.1657
   d = 707.00
     ξy = 0.20024888
   A = 0.01005275
   B = 0.00471972
    with pt = 0.00229194
        pc = 0.00368581
        pv = 0.00398517
        N = 21249.44
        b = 950.00
         " = 0.06082037
ξy_comp = 1.5783869E-005
with fc* (12.3, (ACI 440)) = 33.25688
    fc = 33.00
    fl = 0.43533893
    b = bmax = 950.00
    h = hmax = 750.00
    Ag = 0.5625
       ρg = pt + pc + pv = 0.00996292
    rc = 40.00
    Ae/Ac = 0.30198841
    Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
   effective strain from (12.5) and (12.12), efe = 0.004
    εfu = 0.01
   Ef = 64828.00
   Ec = 26999.444
    ξy = 0.19868555
   A = 0.00989157
   B = 0.00462988
    with Es = 200000.00
CONFIRMATION: ξy = 0.19959754 < t/d

Calculation of ratio lb/ld

Lap Length: ld/ld,min = 0.38756552

lb = 300.00

ld = 774.0627

Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

    = 1

   db = 16.66667

   Mean strength value of all re-bars: fy = 524.4464

   Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)

    t = 1.00

    s = 0.80

    e = 1.00

   cb = 25.00

   Ktr = 1.37392

    Atr = Min(Atr_x,Atr_y) = 257.6106

    where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis

    s = Max(s_external,s_internal) = 250.00

    n = 30.00

 - 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/VCol0E = 0.56344875

   d = d_external = 707.00

   s = s_external = 0.00

- t = s1 + s2 + 2*tf/bw*(ffe/fs) = 0.00568407

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

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

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

      s1 = 100.00

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

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

      Lstir2 = 1568.00, is the total Length of all stirrups parallel to loading (shear) direction

      s2 = 250.00

  The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution

  where f = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises f to steel strength

  All these variables have already been given in Shear control ratio calculation.

  For the normalisation fs of jacket is used.

   NUD = 21249.44

   Ag = 562500.00

   f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 26.93333

   fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein = 529.9972

   fytE = (fy_ext_Trans_Reinf* s1+fy_int_Trans_Reinf* s2)/(s1+ s2) = 538.146

pl = Area_Tot_Long_Rein/(b*d) = 0.00996292

   b = 950.00

   d = 707.00

   f'cE = 26.93333

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

At local axis: 2

Integration Section: (b)

Calculation No. 15

column C1, Floor 1

Limit State: 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 JTC1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rcjtcs

Constant Properties

Knowledge Factor,   = 0.90
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of   y for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.44
##

Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = lb = 300.00
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 = 28326.959
Shear Force, Va = -14.24369
EDGE -B-
Bending Moment, Mb = 15143.524
Shear Force, Vb = 14.24369
BOTH EDGES
Axial Force, F = -21249.44
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1539.38
      -Compression: Asl,com = 2475.575
        -Middle: Asl,mid = 2676.637
Mean Diameter of Tension Reinforcement, DbL,ten = 16.57143

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR =   *Vn = 1.0171E+006
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 1.1301E+006
   VCol = 1.1301E+006
   knl = 1.00
      displacement_ductility_demand = 2.1972219E-005

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 = 20.80, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
     Mu = 15143.524
     Vu = 14.24369
  d = 0.8*h = 600.00
  Nu = 21249.44
  Ag = 337500.00

From (11.5.4.8), ACI 318-14: $V_s = V_{s,jacket} + V_{s,core} = 824756.036$
  where:
$V_{s,jacket} = V_{s,j1} + V_{s,j2} = 753982.237$
$V_{s,j1} = 471238.898$ is calculated for section web jacket, with:
    $d = 600.00$
    $Av = 157079.633$
    $fy = 500.00$
    $s = 100.00$
$V_{s,j1}$ is multiplied by $Col,j1 = 1.00$
    $s/d = 0.16666667$
$V_{s,j2} = 282743.339$ is calculated for section flange jacket, with:
    $d = 360.00$
    $Av = 157079.633$
    $fy = 500.00$
    $s = 100.00$
$V_{s,j2}$ is multiplied by $Col,j2 = 1.00$
    $s/d = 0.27777778$
$V_{s,core} = V_{s,c1} + V_{s,c2} = 70773.799$
$V_{s,c1} = 70773.799$ is calculated for section web core, with:
    $d = 440.00$
    $Av = 100530.965$
    $fy = 400.00$
    $s = 250.00$
$V_{s,c1}$ is multiplied by $Col,c1 = 1.00$
    $s/d = 0.56818182$
$V_{s,c2} = 0.00$ is calculated for section flange core, with:
    $d = 200.00$
    $Av = 100530.965$
    $fy = 400.00$
    $s = 250.00$
$V_{s,c2}$ is multiplied by $Col,c2 = 0.00$
    $s/d = 1.25$
V_f ((11-3)-(11.4), ACI 440) $= 372533.843$
   $\psi f = 0.95$, 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 $V_f(\ ,\ )$, 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: $\alpha 1 = b1 + 90° = 90.00$
$V_f = Min(|V_f(45,\ \alpha 1)|, |V_f(-45, a1)|)$, with:
total thickness per orientation, $tf1 = NL*t/NoDir = 1.016$
$dfv = d$ (figure 11.2, ACI 440) $= 707.00$
ffe ((11-5), ACI 440) $= 259.312$
   $Ef = 64828.00$
    $\epsilon fe = 0.004$, from (11.6a), ACI 440
     with $\epsilon fu = 0.01$
From (11-11), ACI 440: $Vs + Vf <= 818016.733$
   $bw = 450.00$

----
displacement_ductility_demand is calculated as $\ /\ y$

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

From analysis, chord rotation $= 2.4882004E\text{-}008$
 $\theta y = (My*Ls/3)/EIeff = 0.00113243$ ((4.29),Biskinis Phd))
 $My = 5.5411E+008$
 $Ls = M/V$ (with $Ls > 0.1*L$ and $Ls < 2*L$) $= 1063.174$
 From table 10.5, ASCE 41_17: $EIeff = factor*Ec*Ig = 1.7341E+014$
    $factor = 0.30$
     $Ag = 562500.00$
     Mean concrete strength: $fc' = (fc'\_jacket*Area\_jacket + fc'\_core*Area\_core)/Area\_section = 26.93333$
     $N = 21249.44$
    $Ec*Ig = Ec\_jacket*Ig\_jacket + Ec\_core*Ig\_core = 5.7803E+014$

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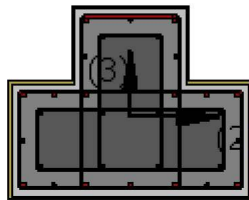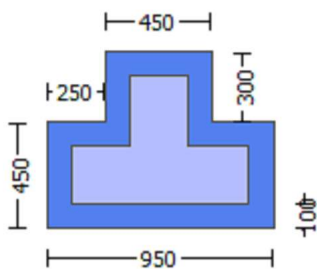----------------------------------------------------------
----------------------------------------------------------

Calculation of Yielding Moment My
----------------------------------------------------------
Calculation of  y and My according to Annex 7  -
----------------------------------------------------------
Assuming neutral axis within flange ( y < t/d, compression zone rectangular) with:
flange width, b = 950.00
web width, bw = 450.00
flange thickness, t = 450.00
----------------------------------------------------------
  y = Min( y_ten,  y_com)
  y_ten = 3.1141730E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 352.1657
    d = 707.00
     y = 0.20024888
    A = 0.01005275
    B = 0.00471972
     with pt = 0.00229194
         pc = 0.00368581
         pv = 0.00398517
         N = 21249.44
         b = 950.00
         " = 0.06082037
  y_comp = 1.5783869E-005
 with fc* (12.3, (ACI 440)) = 33.25688
    fc = 33.00
    fl = 0.43533893
    b = bmax = 950.00
    h = hmax = 750.00
    Ag = 0.5625
      g = pt + pc + pv = 0.00996292
     rc = 40.00
     Ae/Ac = 0.30198841
     Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
   effective strain from (12.5) and (12.12), efe = 0.004
    fu = 0.01
   Ef = 64828.00
   Ec = 26999.444
    y = 0.19868555
   A = 0.00989157
   B = 0.00462988
    with Es = 200000.00
CONFIRMATION:  y = 0.19959754 < t/d
----------------------------------------------------------
----------------------------------------------------------

Calculation of ratio lb/ld
----------------------------------------------------------
Lap Length: ld/ld,min = 0.38756552
lb = 300.00
ld = 774.0627
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
    = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 524.4464
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
    t = 1.00
    s = 0.80
    e = 1.00
   cb = 25.00
   Ktr = 1.37392
    Atr = Min(Atr_x,Atr_y) = 257.6106
    where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
    s = Max(s_external,s_internal) = 250.00
```

n = 30.00

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

Calculation No. 16

column C1, Floor 1

Limit State: 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 JTC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rcjtcs

Constant Properties

Knowledge Factor,   = 0.90
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 555.55
##
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.02437
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
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 = -0.00053663
EDGE -B-
Shear Force, Vb = 0.00053663
BOTH EDGES
Axial Force, F = -20792.011
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
    -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 1539.38
    -Compression: Asl,com = 2475.575
       -Middle: Asl,mid = 2676.637

Calculation of Shear Capacity ratio , Ve/Vr = 0.56344875
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 624335.951
with
Mpr1 = Max(Mu1+ , Mu1-) = 9.3650E+008
   Mu1+ = 6.7320E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
   Mu1- = 9.3650E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 9.3650E+008
   Mu2+ = 6.7320E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
   Mu2- = 9.3650E+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 = 9.1136953E-006
Mu = 6.7320E+008
----
with full section properties:
  b = 950.00
  d = 707.00
  d' = 43.00
  ν = 0.00093808
    N = 20792.011
  fc = 33.00
   εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.01209008
     The Shear_factor is considered equal to 1 (pure moment strength)
     From (5.4b), TBDY: εcu = 0.01209008
       ωwe ((5.4c), TBDY) = αse* ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.04611842
     where ωf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

       ωfx = 0.03444474
     Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
     αf = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
       bmax = 950.00
       hmax = 750.00
       From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00451556
         bw = 450.00
       effective stress from (A.35), ff,e = 881.8461

       ωfy = 0.03444474
     Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
     αf = 0.28545185
     with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
       bmax = 950.00
       hmax = 750.00
       From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00451556
         bw = 450.00
       effective stress from (A.35), ff,e = 881.8461

       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 = 0.53375773
         αse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
         The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
         of the rectangular sections confinement, which is expressed by (5.4d).
         The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
         "Theoretical Stress-Strain Model for Confined Concrete."
         J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
         Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
                 is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
         Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
                 is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                 equal to half the clear spacing between external hoops.
         AnoConf1 = 173066.667 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
       αse2 (>=αse1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
         The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
         of the rectangular sections confinement, which is expressed by (5.4d).
         The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)

"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.
AnoConf2 = 110709.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548

----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 458.0986
fy1 = 381.7488
su1 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 381.7488
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 453.4475
fy2 = 377.8729
su2 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
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 = 377.8729

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00143155
  shv = 0.00458096
 ftv = 455.2307
 fyv = 379.359
  suv = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.31005242
     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 = 379.359
     with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.02651348
  2 = Asl,com/(b*d)*(fs2/fc) = 0.04220509
  v = Asl,mid/(b*d)*(fsv/fc) = 0.04581238
and confined core properties:
  b = 890.00
  d = 677.00
  d' = 13.00
 fcc (5A.2, TBDY) = 33.80412
   cc (5A.5, TBDY) = 0.00224367
     c = confinement factor = 1.02437
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.029555
   2 = Asl,com/(b*d)*(fs2/fc) = 0.0470467
   v = Asl,mid/(b*d)*(fsv/fc) = 0.0510678
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.14547789
Mu = MRc (4.14) = 6.7320E+008
 u =   su (4.1) = 9.1136953E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
   = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
    t = 1.00
    s = 0.80
    e = 1.00
  cb = 25.00
  Ktr = 1.37392
   Atr = Min(Atr_x,Atr_y) = 257.6106
   where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
   s = Max(s_external,s_internal) = 250.00
   n = 30.00

Calculation of Mu1-

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

  φu = 9.8526632E-006

Mu = 9.3650E+008

----

with full section properties:

  b = 450.00

  d = 707.00

  d' = 43.00

  ν = 0.00198039

    N = 20792.011

  fc = 33.00

   εco (5A.5, TBDY) = 0.002

  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.01209008

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

    From (5.4b), TBDY: εcu = 0.01209008

      ωwe ((5.4c), TBDY) = αse* ρsh,min*fywe/fce+ Min(ωfx, ωfy) = 0.04611842

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

      ωfx = 0.03444474

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

    αf = 0.28545185

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

      bmax = 950.00

      hmax = 750.00

      From EC8 A4.4.3(6), ρf = 2tf/bw = 0.00451556

        bw = 450.00

      effective stress from (A.35), ff,e = 881.8461

      ωfy = 0.03444474

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

    αf = 0.28545185

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

      bmax = 950.00

      hmax = 750.00

      From EC8 A4.4.3(6), ρf = 2tf/bw = 0.00451556

        bw = 450.00

      effective stress from (A.35), ff,e = 881.8461

      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 = 0.53375773

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

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

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

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

        "Theoretical Stress-Strain Model for Confined Concrete."

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

        Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and

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

        Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and

              is calculated by reducing all the dimensions of the area Aconf,max1 by a length

              equal to half the clear spacing between external hoops.

      AnoConf1 = 173066.667 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).

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

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

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

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

        "Theoretical Stress-Strain Model for Confined Concrete."

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

        Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and

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

        Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and

              is calculated by reducing all the dimensions of the area Aconf,max2 by a length

equal to half the clear spacing between internal hoops.
AnoConf2 = 110709.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

----

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 453.4475
fy1 = 377.8729
su1 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 377.8729
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 458.0986
fy2 = 381.7488
su2 = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
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 = 381.7488
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00143155
shv = 0.00458096
ftv = 455.2307
fyv = 379.359
suv = 0.00550601

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
  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 = 379.359
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.08909964
  2 = Asl,com/(b*d)*(fs2/fc) = 0.05597289
  v = Asl,mid/(b*d)*(fsv/fc) = 0.09671502
and confined core properties:
  b = 390.00
  d = 677.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.80412
   cc (5A.5, TBDY) = 0.00224367
     c = confinement factor = 1.02437
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.10736299
   2 = Asl,com/(b*d)*(fs2/fc) = 0.06744603
   v = Asl,mid/(b*d)*(fsv/fc) = 0.11653935
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.20956863
Mu = MRc (4.14) = 9.3650E+008
  u =   su (4.1) = 9.8526632E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
    = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
    t = 1.00
    s = 0.80
    e = 1.00
  cb = 25.00
  Ktr = 1.37392
   Atr = Min(Atr_x,Atr_y) = 257.6106
   where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
   s = Max(s_external,s_internal) = 250.00
   n = 30.00

Calculation of Mu2+

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
  u = 9.1136953E-006
Mu = 6.7320E+008
----
with full section properties:

b = 950.00
d = 707.00
d' = 43.00
v = 0.00093808
  N = 20792.011
fc = 33.00
  co (5A.5, TBDY) = 0.002
Final value of cu: $cu^* = shear\_factor * Max(cu, cc) = 0.01209008$
  The Shear_factor is considered equal to 1 (pure moment strength)
  From (5.4b), TBDY: cu = 0.01209008
    we ((5.4c), TBDY) = ase* $\omega_{sh,min}$*fywe/fce + Min(fx, fy) = 0.04611842
  where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
  ----
    fx = 0.03444474
  Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
  af = 0.28545185
  with Unconfined area = $((bmax-2R)^2 + (hmax-2R)^2)/3$ = 160566.667
    bmax = 950.00
    hmax = 750.00
    From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
      bw = 450.00
    effective stress from (A.35), ff,e = 881.8461
  ----
    fy = 0.03444474
  Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
  af = 0.28545185
  with Unconfined area = $((bmax-2R)^2 + (hmax-2R)^2)/3$ = 160566.667
    bmax = 950.00
    hmax = 750.00
    From EC8 A.4.4.3(6), pf = 2tf/bw = 0.00451556
      bw = 450.00
    effective stress from (A.35), ff,e = 881.8461

    R = 40.00
    Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
    fu,f = 1055.00
    Ef = 64828.00
    εu,f = 0.015
    ase ((5.4d), TBDY) = (ase1*Aext + ase2*Aint)/Asec = 0.53375773
      ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
      The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
      of the rectangular sections confinement, which is expressed by (5.4d).
      The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
      "Theoretical Stress-Strain Model for Confined Concrete."
      J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
      Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
          is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
      Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
          is calculated by reducing all the dimensions of the area Aconf,max1 by a length
          equal to half the clear spacing between external hoops.
     AnoConf1 = 173066.667 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
    ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
      The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
      of the rectangular sections confinement, which is expressed by (5.4d).
      The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
      "Theoretical Stress-Strain Model for Confined Concrete."
      J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
      Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
          is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
      Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
          is calculated by reducing all the dimensions of the area Aconf,max2 by a length
          equal to half the clear spacing between internal hoops.
     AnoConf2 = 110709.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
    psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
  Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

```
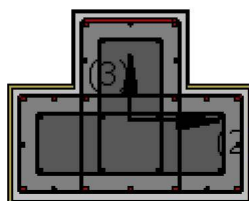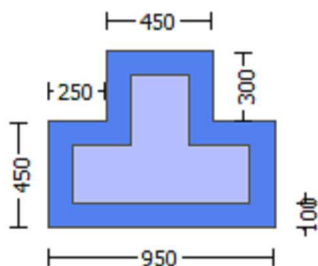        psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
           Lstir1 (Length of stirrups along Y) = 2160.00
           Astir1 (stirrups area) = 78.53982
        psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
           Lstir2 (Length of stirrups along Y) = 1568.00
           Astir2 (stirrups area) = 50.26548
     --------------------------------------------------------------------
        psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
        psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
           Lstir1 (Length of stirrups along X) = 2560.00
           Astir1 (stirrups area) = 78.53982
        psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
           Lstir2 (Length of stirrups along X) = 1968.00
           Astir2 (stirrups area) = 50.26548
     --------------------------------------------------------------------
        Asec = 562500.00
        s1 = 100.00
        s2 = 250.00
      fywe1 = 694.45
      fywe2 = 555.55
      fce  = 33.00
   From ((5.A5), TBDY), TBDY:  cc = 0.00224367
        c  = confinement factor = 1.02437
  y1 = 0.00143155
  sh1 = 0.00458096
 ft1 = 458.0986
 fy1 = 381.7488
  su1 = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.31005242
     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 = 381.7488
      with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
  y2 = 0.00143155
  sh2 = 0.00458096
 ft2 = 453.4475
 fy2 = 377.8729
  su2 = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
     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 = 377.8729
      with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00143155
  shv = 0.00458096
 ftv = 455.2307
 fyv = 379.359
  suv = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.31005242
     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 = 379.359
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.02651348
2 = Asl,com/(b*d)*(fs2/fc) = 0.04220509
v = Asl,mid/(b*d)*(fsv/fc) = 0.04581238
and confined core properties:
b = 890.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 33.80412
cc (5A.5, TBDY) = 0.00224367
c = confinement factor = 1.02437
1 = Asl,ten/(b*d)*(fs1/fc) = 0.029555
2 = Asl,com/(b*d)*(fs2/fc) = 0.0470467
v = Asl,mid/(b*d)*(fsv/fc) = 0.0510678
Case/Assumption: Unconfinesd full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.14547789
Mu = MRc (4.14) = 6.7320E+008
u =   su (4.1) = 9.1136953E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 16.66667
Mean strength value of all re-bars: fy = 655.558
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
t = 1.00
s = 0.80
e = 1.00
cb = 25.00
Ktr = 1.37392
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 30.00

Calculation of Mu2-

Calculation of ultimate curvature   u according to 4.1, Biskinis/Fardis 2013:
u = 9.8526632E-006
Mu = 9.3650E+008
----
with full section properties:
b = 450.00
d = 707.00
d' = 43.00
v = 0.00198039
N = 20792.011
fc = 33.00

co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01209008
  The Shear_factor is considered equal to 1 (pure moment strength)
  From (5.4b), TBDY: cu = 0.01209008
    we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.04611842
  where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----
  fx = 0.03444474
Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
af = 0.28545185
with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
  bmax = 950.00
  hmax = 750.00
  From EC8 A4.4.3(6), pf = 2tf/bw = 0.00451556
    bw = 450.00
  effective stress from (A.35), ff,e = 881.8461
----
  fy = 0.03444474
Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
af = 0.28545185
with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
  bmax = 950.00
  hmax = 750.00
  From EC8 A4.4.3(6), pf = 2tf/bw = 0.00451556
    bw = 450.00
  effective stress from (A.35), ff,e = 881.8461

  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 = 0.53375773
    ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
    The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
    of the rectangular sections confinement, which is expressed by (5.4d).
    The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
    "Theoretical Stress-Strain Model for Confined Concrete."
    J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
    Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
      is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
    Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
      is calculated by reducing all the dimensions of the area Aconf,max1 by a length
      equal to half the clear spacing between external hoops.
    AnoConf1 = 173066.667 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).
  ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
    The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
    of the rectangular sections confinement, which is expressed by (5.4d).
    The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
    "Theoretical Stress-Strain Model for Confined Concrete."
    J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
    Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
      is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
    Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
      is calculated by reducing all the dimensions of the area Aconf,max2 by a length
      equal to half the clear spacing between internal hoops.
    AnoConf2 = 110709.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).
    psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
  Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
----
    psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
    psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
      Lstir1 (Length of stirrups along Y) = 2160.00
      Astir1 (stirrups area) = 78.53982
    psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
      Lstir2 (Length of stirrups along Y) = 1568.00

```
                Astir2 (stirrups area) = 50.26548
        --------------------------------------------------------------------
            psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
            psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
               Lstir1 (Length of stirrups along X) = 2560.00
               Astir1 (stirrups area) = 78.53982
            psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
               Lstir2 (Length of stirrups along X) = 1968.00
               Astir2 (stirrups area) = 50.26548

        --------------------------------------------------------------------
               Asec = 562500.00
               s1 = 100.00
               s2 = 250.00
            fywe1 = 694.45
            fywe2 = 555.55
            fce  = 33.00
        From ((5.A5), TBDY), TBDY:  cc = 0.00224367
            c = confinement factor = 1.02437
    y1 = 0.00143155
    sh1 = 0.00458096
  ft1 = 453.4475
  fy1 = 377.8729
    su1 = 0.00550601
       using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
       and also multiplied by the shear_factor according to 15.7.1.4, with
       Shear_factor = 1.00
       lo/lou,min = lb/ld = 0.31005242
        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 = 377.8729
         with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
    y2 = 0.00143155
    sh2 = 0.00458096
  ft2 = 458.0986
  fy2 = 381.7488
    su2 = 0.00550601
       using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
        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 = 381.7488
         with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
    yv = 0.00143155
    shv = 0.00458096
  ftv = 455.2307
  fyv = 379.359
    suv = 0.00550601
       using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
       and also multiplied by the shear_factor according to 15.7.1.4, with
       Shear_factor = 1.00
       lo/lou,min = lb/ld = 0.31005242
        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 = 379.359
         with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
```

```
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.08909964
    2 = Asl,com/(b*d)*(fs2/fc) = 0.05597289
    v = Asl,mid/(b*d)*(fsv/fc) = 0.09671502
and confined core properties:
  b = 390.00
  d = 677.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.80412
   cc (5A.5, TBDY) = 0.00224367
      c  = confinement factor = 1.02437
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.10736299
    2 = Asl,com/(b*d)*(fs2/fc) = 0.06744603
    v = Asl,mid/(b*d)*(fsv/fc) = 0.11653935
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.20956863
Mu = MRc (4.14) = 9.3650E+008
  u =   su (4.1) = 9.8526632E-006
----------------------------------------------------------------

Calculation of ratio lb/ld
----------------------------------------------------------------
Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
    = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
    t = 1.00
    s = 0.80
    e = 1.00
  cb = 25.00
  Ktr = 1.37392
   Atr = Min(Atr_x,Atr_y) = 257.6106
   where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
   s = Max(s_external,s_internal) = 250.00
   n = 30.00
------------------------------------------------------------------------
------------------------------------------------------------------------
------------------------------------------------------------------------
------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.1081E+006
------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 1.1081E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 1.1081E+006
  knl = 1 (zero step-static loading)
-----------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+   f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
-----------------------------------------------------------
    = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 4.00
     Mu = 761.1315
     Vu = 0.00053663
  d = 0.8*h = 600.00
  Nu = 20792.011
  Ag = 337500.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 916401.511
```

where:
Vs,jacket = Vs,j1 + Vs,j2 = 837764.743
Vs,j1 = 523602.964 is calculated for section web jacket, with:
  d = 600.00
  Av = 157079.633
  fy = 555.56
  s = 100.00
Vs,j1 is multiplied by Col,j1 = 1.00
  s/d = 0.16666667
Vs,j2 = 314161.779 is calculated for section flange jacket, with:
  d = 360.00
  Av = 157079.633
  fy = 555.56
  s = 100.00
Vs,j2 is multiplied by Col,j2 = 1.00
  s/d = 0.27777778
Vs,core = Vs,c1 + Vs,c2 = 78636.768
Vs,c1 = 78636.768 is calculated for section web core, with:
  d = 440.00
  Av = 100530.965
  fy = 444.44
  s = 250.00
Vs,c1 is multiplied by Col,c1 = 1.00
  s/d = 0.56818182
Vs,c2 = 0.00 is calculated for section flange core, with:
  d = 200.00
  Av = 100530.965
  fy = 444.44
  s = 250.00
Vs,c2 is multiplied by Col,c2 = 0.00
  s/d = 1.25
Vf ((11-3)-(11.4), ACI 440) = 372533.843
  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) = 707.00
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 <= 930841.148
  bw = 450.00

Calculation of Shear Strength at edge 2, Vr2 = 1.1081E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 1.1081E+006
  knl = 1 (zero step-static loading)

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

  = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 4.00
  Mu = 761.1315
  Vu = 0.00053663
d = 0.8*h = 600.00
Nu = 20792.011
Ag = 337500.00

From (11.5.4.8), ACI 318-14: $V_s = V_{s,jacket} + V_{s,core} = 916401.511$
  where:
 $V_{s,jacket} = V_{s,j1} + V_{s,j2} = 837764.743$
  $V_{s,j1} = 523602.964$ is calculated for section web jacket, with:
    d = 600.00
    Av = 157079.633
    fy = 555.56
    s = 100.00
  $V_{s,j1}$ is multiplied by   Col,j1 = 1.00
    s/d = 0.16666667
  $V_{s,j2} = 314161.779$ is calculated for section flange jacket, with:
    d = 360.00
    Av = 157079.633
    fy = 555.56
    s = 100.00
  $V_{s,j2}$ is multiplied by   Col,j2 = 1.00
    s/d = 0.27777778
 $V_{s,core} = V_{s,c1} + V_{s,c2} = 78636.768$
  $V_{s,c1} = 78636.768$ is calculated for section web core, with:
    d = 440.00
    Av = 100530.965
    fy = 444.44
    s = 250.00
  $V_{s,c1}$ is multiplied by   Col,c1 = 1.00
    s/d = 0.56818182
  $V_{s,c2} = 0.00$ is calculated for section flange core, with:
    d = 200.00
    Av = 100530.965
    fy = 444.44
    s = 250.00
  $V_{s,c2}$ is multiplied by   Col,c2 = 0.00
    s/d = 1.25
  Vf ((11-3)-(11.4), ACI 440) = 372533.843
    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: α_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) = 707.00
  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 <= 930841.148
    bw = 450.00

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

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

Constant Properties

Knowledge Factor,   = 0.90
Mean strength values are used for both shear and moment calculations.
Consequently:

Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 555.55
###
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.02437
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
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 = -4.4410684E-008
EDGE -B-
Shear Force, Vb = 4.4410684E-008
BOTH EDGES
Axial Force, F = -20792.011
Longitudinal Reinforcement Area Distribution (in 2 divisions)
      -Tension: Aslt = 0.00
    -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
      -Tension: Asl,ten = 1539.38
    -Compression: Asl,com = 1539.38
        -Middle: Asl,mid = 3612.832

Calculation of Shear Capacity ratio , Ve/Vr = 0.39733369

Member Controlled by Flexure (Ve/Vr < 1)

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 646432.814

with

Mpr1 = Max(Mu1+ , Mu1-) = 9.6965E+008

  Mu1+ = 9.6965E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination

  Mu1- = 9.6965E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination

Mpr2 = Max(Mu2+ , Mu2-) = 9.6965E+008

  Mu2+ = 9.6965E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination

  Mu2- = 9.6965E+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 = 7.3807483E-006

Mu = 9.6965E+008

----

with full section properties:

  b = 450.00

  d = 907.00

  d' = 43.00

  v = 0.0015437

    N = 20792.011

  fc = 33.00

   εco (5A.5, TBDY) = 0.002

  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.01209008

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

    From (5.4b), TBDY: εcu = 0.01209008

      ωwe ((5.4c), TBDY) = αse*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.04611842

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

     ωfx = 0.03444474

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

    αf = 0.28545185

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

      bmax = 950.00

      hmax = 750.00

      From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00451556

        bw = 450.00

      effective stress from (A.35), ff,e = 881.8461

     ωfy = 0.03444474

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

    αf = 0.28545185

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

      bmax = 950.00

      hmax = 750.00

      From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00451556

        bw = 450.00

      effective stress from (A.35), ff,e = 881.8461

    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 = 0.53375773

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

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

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

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

"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
    is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
    is calculated by reducing all the dimensions of the area Aconf,max1 by a length
    equal to half the clear spacing between external hoops.
AnoConf1 = 173066.667 is the unconfined external core area which is equal to   bi2/6 as defined at (A.2).
ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
    The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
    of the rectangular sections confinement, which is expressed by (5.4d).
    The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
    "Theoretical Stress-Strain Model for Confined Concrete."
    J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
    is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
    is calculated by reducing all the dimensions of the area Aconf,max2 by a length
    equal to half the clear spacing between internal hoops.
AnoConf2 = 110709.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
    Lstir1 (Length of stirrups along Y) = 2160.00
    Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
    Lstir2 (Length of stirrups along Y) = 1568.00
    Astir2 (stirrups area) = 50.26548
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
    Lstir1 (Length of stirrups along X) = 2560.00
    Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
    Lstir2 (Length of stirrups along X) = 1968.00
    Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
    c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 458.0986
fy1 = 381.7488
su1 = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.31005242
    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 = 381.7488
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 458.0986

fy2 = 381.7488
  su2 = 0.00550601
    using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
     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 = 381.7488
     with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
   yv = 0.00143155
   shv = 0.00458096
  ftv = 452.7869
  fyv = 377.3224
   suv = 0.00550601
     using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
     and also multiplied by the shear_factor according to 15.7.1.4, with
     Shear_factor = 1.00
     lo/lou,min = lb/ld = 0.31005242
      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 = 377.3224
      with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.04363047
   2 = Asl,com/(b*d)*(fs2/fc) = 0.04363047
   v = Asl,mid/(b*d)*(fsv/fc) = 0.10121073
and confined core properties:
   b = 390.00
   d = 877.00
   d' = 13.00
   fcc (5A.2, TBDY) = 33.80412
    cc (5A.5, TBDY) = 0.00224367
      c = confinement factor = 1.02437
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.05206495
    2 = Asl,com/(b*d)*(fs2/fc) = 0.05206495
    v = Asl,mid/(b*d)*(fsv/fc) = 0.12077642
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.17751206
Mu = MRc (4.14) = 9.6965E+008
  u =   su (4.1) = 7.3807483E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
    = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
    t = 1.00
    s = 0.80
    e = 1.00

```
   cb = 25.00
   Ktr = 1.37392
    Atr = Min(Atr_x,Atr_y) = 257.6106
    where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
    s = Max(s_external,s_internal) = 250.00
    n = 30.00
-------------------------------------------------------------------------
-------------------------------------------------------------------------
-------------------------------------------------------------------------
Calculation of Mu1-
-------------------------------------------------------------------------


-------------------------------------------------------------------------
Calculation of ultimate curvature  u according to 4.1, Biskinis/Fardis 2013:
  u = 7.3807483E-006
Mu = 9.6965E+008
-------------------------------------------------------------------------
with full section properties:
   b = 450.00
   d = 907.00
   d' = 43.00
   v = 0.0015437
     N = 20792.011
   fc = 33.00
    co (5A.5, TBDY) = 0.002
   Final value of  cu:  cu* = shear_factor * Max( cu, cc) = 0.01209008
      The Shear_factor is considered equal to 1 (pure moment strength)
      From (5.4b), TBDY:  cu = 0.01209008
        we ((5.4c), TBDY) = ase* sh,min*fywe/fce+ Min( fx,  fy) = 0.04611842
      where  f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
      ----------------------------------------------------------------
       fx = 0.03444474
      Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
      af = 0.28545185
      with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
        bmax = 950.00
        hmax = 750.00
        From EC8 A4.4.3(6), pf = 2tf/bw = 0.00451556
          bw = 450.00
        effective stress from (A.35), ff,e = 881.8461
      ----------------------------------------------------------------
       fy = 0.03444474
      Expression ((15B.6), TBDY) is modified as af = 1 - (Unconfined area)/(total area)
      af = 0.28545185
      with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
        bmax = 950.00
        hmax = 750.00
        From EC8 A4.4.3(6), pf = 2tf/bw = 0.00451556
          bw = 450.00
        effective stress from (A.35), ff,e = 881.8461
      ----------------------------------------------------------------
        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 = 0.53375773
          ase1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
          The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
          of the rectangular sections confinement, which is expressed by (5.4d).
          The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
          "Theoretical Stress-Strain Model for Confined Concrete."
          J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
          Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
                  is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
          Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
                  is calculated by reducing all the dimensions of the area Aconf,max1 by a length
```

equal to half the clear spacing between external hoops.

AnoConf1 = 173066.667 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).

ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773

The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
of the rectangular sections confinement, which is expressed by (5.4d).
The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.

Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.

Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
is calculated by reducing all the dimensions of the area Aconf,max2 by a length
equal to half the clear spacing between internal hoops.

AnoConf2 = 110709.333 is the unconfined internal core area which is equal to bi2/6 as defined at (A.2).

psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578

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

----

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578

psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
Lstir1 (Length of stirrups along Y) = 2160.00
Astir1 (stirrups area) = 78.53982

psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
Lstir2 (Length of stirrups along Y) = 1568.00
Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307

psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
Lstir1 (Length of stirrups along X) = 2560.00
Astir1 (stirrups area) = 78.53982

psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
Lstir2 (Length of stirrups along X) = 1968.00
Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00224367
c = confinement factor = 1.02437

y1 = 0.00143155
sh1 = 0.00458096
ft1 = 458.0986
fy1 = 381.7488
su1 = 0.00550601

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 381.7488
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.00143155
sh2 = 0.00458096
ft2 = 458.0986
fy2 = 381.7488
su2 = 0.00550601

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242

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 = 381.7488
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00143155
shv = 0.00458096
ftv = 452.7869
fyv = 377.3224
suv = 0.00550601
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
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 = 377.3224
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04363047
2 = Asl,com/(b*d)*(fs2/fc) = 0.04363047
v = Asl,mid/(b*d)*(fsv/fc) = 0.10121073
and confined core properties:
b = 390.00
d = 877.00
d' = 13.00
fcc (5A.2, TBDY) = 33.80412
cc (5A.5, TBDY) = 0.00224367
c = confinement factor = 1.02437
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05206495
2 = Asl,com/(b*d)*(fs2/fc) = 0.05206495
v = Asl,mid/(b*d)*(fsv/fc) = 0.12077642
Case/Assumption: Unconfinesd full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.17751206
Mu = MRc (4.14) = 9.6965E+008
u = su (4.1) = 7.3807483E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 16.66667
Mean strength value of all re-bars: fy = 655.558
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
t = 1.00
s = 0.80
e = 1.00
cb = 25.00
Ktr = 1.37392
Atr = Min(Atr_x,Atr_y) = 257.6106
where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
s = Max(s_external,s_internal) = 250.00
n = 30.00

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
  φu = 7.3807483E-006
Mu = 9.6965E+008
----
with full section properties:
  b = 450.00
  d = 907.00
  d' = 43.00
  ν = 0.0015437
    N = 20792.011
  fc = 33.00
   εco (5A.5, TBDY) = 0.002
  Final value of εcu: εcu* = shear_factor * Max(εcu, εcc) = 0.01209008
    The Shear_factor is considered equal to 1 (pure moment strength)
    From (5.4b), TBDY: εcu = 0.01209008
      ωwe ((5.4c), TBDY) = ρse*αsh,min*fywe/fce+Min(ωfx, ωfy) = 0.04611842
    where ωf = αf*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

      ωfx = 0.03444474
    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
    αf = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

      ωfy = 0.03444474
    Expression ((15B.6), TBDY) is modified as αf = 1 - (Unconfined area)/(total area)
    αf = 0.28545185
    with Unconfined area = ((bmax-2R)^2+(hmax-2R)^2)/3 = 160566.667
      bmax = 950.00
      hmax = 750.00
      From EC8 A.4.4.3(6), ρf = 2tf/bw = 0.00451556
        bw = 450.00
      effective stress from (A.35), ff,e = 881.8461

      R = 40.00
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
      fu,f = 1055.00
      Ef = 64828.00
       εu,f = 0.015
      ρse ((5.4d), TBDY) = (ρse1*Aext+ρse2*Aint)/Asec = 0.53375773
        ρse1 = Max(((Aconf,max1-AnoConf1)/Aconf,max1)*(Aconf,min1/Aconf,max1),0) = 0.53375773
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)
        "Theoretical Stress-Strain Model for Confined Concrete."
        J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
        Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and
                is calculated as the area of core enclosed by the center lines of the external perimeter hoops.
        Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and
                is calculated by reducing all the dimensions of the area Aconf,max1 by a length
                equal to half the clear spacing between external hoops.
        AnoConf1 = 173066.667 is the unconfined external core area which is equal to Σbi2/6 as defined at (A.2).
      ρse2 (>=ρse1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773
        The definitions of AnoConf, Aconf,min and Aconf,max are derived from generalization
        of the rectangular sections confinement, which is expressed by (5.4d).
        The generalization is done according to Mander, J., Priestley, M., and Park, R. (1988)

"Theoretical Stress-Strain Model for Confined Concrete."
J. Struct. Eng., 10.1061/(ASCE)0733-9445(1988)114:8(1804), 1804-1826.
Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and
   is calculated as the area of core enclosed by the center lines of the internal perimeter hoops.
Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and
   is calculated by reducing all the dimensions of the area Aconf,max2 by a length
   equal to half the clear spacing between internal hoops.
AnoConf2 = 110709.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578
Expression (5.4d) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00301593
   Lstir1 (Length of stirrups along Y) = 2160.00
   Astir1 (stirrups area) = 78.53982
psh2 (5.4d) = Lstir2*Astir2/(Asec*s2) = 0.00056047
   Lstir2 (Length of stirrups along Y) = 1568.00
   Astir2 (stirrups area) = 50.26548
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307
psh1 ((5.4d), TBDY) = Lstir1*Astir1/(Asec*s1) = 0.00357443
   Lstir1 (Length of stirrups along X) = 2560.00
   Astir1 (stirrups area) = 78.53982
psh2 ((5.4d), TBDY) = Lstir2*Astir2/(Asec*s2) = 0.00070345
   Lstir2 (Length of stirrups along X) = 1968.00
   Astir2 (stirrups area) = 50.26548

Asec = 562500.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.00224367
   c = confinement factor = 1.02437
y1 = 0.00143155
sh1 = 0.00458096
ft1 = 458.0986
fy1 = 381.7488
su1 = 0.00550601
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.31005242
   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 = 381.7488
   with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00143155
sh2 = 0.00458096
ft2 = 458.0986
fy2 = 381.7488
su2 = 0.00550601
   using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242
   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 = 381.7488

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
  yv = 0.00143155
  shv = 0.00458096
 ftv = 452.7869
 fyv = 377.3224
  suv = 0.00550601
   using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
   and also multiplied by the shear_factor according to 15.7.1.4, with
   Shear_factor = 1.00
   lo/lou,min = lb/ld = 0.31005242
    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 = 377.3224
   with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.04363047
  2 = Asl,com/(b*d)*(fs2/fc) = 0.04363047
  v = Asl,mid/(b*d)*(fsv/fc) = 0.10121073
and confined core properties:
  b = 390.00
  d = 877.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.80412
   cc (5A.5, TBDY) = 0.00224367
    c = confinement factor = 1.02437
   1 = Asl,ten/(b*d)*(fs1/fc) = 0.05206495
   2 = Asl,com/(b*d)*(fs2/fc) = 0.05206495
   v = Asl,mid/(b*d)*(fsv/fc) = 0.12077642
Case/Assumption: Unconfinesd full section - Steel rupture
 ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.17751206
Mu = MRc (4.14) = 9.6965E+008
 u = su (4.1) = 7.3807483E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
   = 1
 db = 16.66667
 Mean strength value of all re-bars: fy = 655.558
 Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
   t = 1.00
   s = 0.80
   e = 1.00
 cb = 25.00
 Ktr = 1.37392
  Atr = Min(Atr_x,Atr_y) = 257.6106
  where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
  s = Max(s_external,s_internal) = 250.00
  n = 30.00

Calculation of Mu2-

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

  u = 7.3807483E-006

Mu = 9.6965E+008

----

with full section properties:

  b = 450.00

  d = 907.00

  d' = 43.00

  v = 0.0015437

   N = 20792.011

  fc = 33.00

   co (5A.5, TBDY) = 0.002

  Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.01209008

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

    From (5.4b), TBDY: cu = 0.01209008

      we ((5.4c), TBDY) = ase* sh,min*fywe/fce+ Min(fx,   fy) = 0.04611842

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

    ----

      fx = 0.03444474

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

    af = 0.28545185

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

      bmax = 950.00

      hmax = 750.00

      From EC8 A4.4.3(6), pf = 2tf/bw = 0.00451556

        bw = 450.00

      effective stress from (A.35), ff,e = 881.8461

    ----

      fy = 0.03444474

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

    af = 0.28545185

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

      bmax = 950.00

      hmax = 750.00

      From EC8 A4.4.3(6), pf = 2tf/bw = 0.00451556

        bw = 450.00

      effective stress from (A.35), ff,e = 881.8461

      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 = 0.53375773

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

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

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

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

        "Theoretical Stress-Strain Model for Confined Concrete."

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

        Aconf,max1 = 464100.00 is the confined core area at levels of member with hoops and

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

        Aconf,min1 = 395025.00 is the confined core area at midway between the levels of hoops and

            is calculated by reducing all the dimensions of the area Aconf,max1 by a length

            equal to half the clear spacing between external hoops.

        AnoConf1 = 173066.667 is the unconfined external core area which is equal to bi2/6 as defined at (A.2).

      ase2 (>=ase1) = Max(((Aconf,max2-AnoConf2)/Aconf,max2)*(Aconf,min2/Aconf,max2),0) = 0.53375773

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

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

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

        "Theoretical Stress-Strain Model for Confined Concrete."

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

        Aconf,max2 = 252164.00 is the confined core area at levels of member with hoops and

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

        Aconf,min2 = 111441.00 is the confined core area at midway between the levels of hoops and

            is calculated by reducing all the dimensions of the area Aconf,max2 by a length

equal to half the clear spacing between internal hoops.

AnoConf2 = 110709.333 is the unconfined internal core area which is equal to   bi2/6 as defined at (A.2).

psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 2.40578

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

----

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.40578

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

Lstir1 (Length of stirrups along Y) = 2160.00

Astir1 (stirrups area) = 78.53982

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

Lstir2 (Length of stirrups along Y) = 1568.00

Astir2 (stirrups area) = 50.26548

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.87307

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

Lstir1 (Length of stirrups along X) = 2560.00

Astir1 (stirrups area) = 78.53982

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

Lstir2 (Length of stirrups along X) = 1968.00

Astir2 (stirrups area) = 50.26548

Asec = 562500.00

s1 = 100.00

s2 = 250.00

fywe1 = 694.45

fywe2 = 555.55

fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00224367

c = confinement factor = 1.02437

y1 = 0.00143155

sh1 = 0.00458096

ft1 = 458.0986

fy1 = 381.7488

su1 = 0.00550601

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

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/ld = 0.31005242

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 = 381.7488

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

y2 = 0.00143155

sh2 = 0.00458096

ft2 = 458.0986

fy2 = 381.7488

su2 = 0.00550601

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31005242

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 = 381.7488

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

yv = 0.00143155

shv = 0.00458096

ftv = 452.7869

fyv = 377.3224

suv = 0.00550601

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31005242
  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 = 377.3224
  with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
  1 = Asl,ten/(b*d)*(fs1/fc) = 0.04363047
  2 = Asl,com/(b*d)*(fs2/fc) = 0.04363047
  v = Asl,mid/(b*d)*(fsv/fc) = 0.10121073
and confined core properties:
  b = 390.00
  d = 877.00
  d' = 13.00
  fcc (5A.2, TBDY) = 33.80412
   cc (5A.5, TBDY) = 0.00224367
     c = confinement factor = 1.02437
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.05206495
    2 = Asl,com/(b*d)*(fs2/fc) = 0.05206495
    v = Asl,mid/(b*d)*(fsv/fc) = 0.12077642
Case/Assumption: Unconfinesd full section - Steel rupture
  ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.17751206
Mu = MRc (4.14) = 9.6965E+008
  u =   su (4.1) = 7.3807483E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.31005242
lb = 300.00
ld = 967.5783
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
    = 1
  db = 16.66667
  Mean strength value of all re-bars: fy = 655.558
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
    t = 1.00
    s = 0.80
    e = 1.00
  cb = 25.00
  Ktr = 1.37392
   Atr = Min(Atr_x,Atr_y) = 257.6106
   where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
   s = Max(s_external,s_internal) = 250.00
   n = 30.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.6269E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.6269E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 1.6269E+006
  knl = 1 (zero step-static loading)

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

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

     = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
    Mu = 0.62237178
    Vu = 4.4410684E-008
  d = 0.8*h = 760.00
  Nu = 20792.011
  Ag = 427500.00
  From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 1.0846E+006
  where:
  Vs,jacket = Vs,j1 + Vs,j2 = 977392.20
  Vs,j1 = 314161.779 is calculated for section web jacket, with:
    d = 360.00
    Av = 157079.633
    fy = 555.56
    s = 100.00
  Vs,j1 is multiplied by   Col,j1 = 1.00
    s/d = 0.27777778
  Vs,j2 = 663230.422 is calculated for section flange jacket, with:
    d = 760.00
    Av = 157079.633
    fy = 555.56
    s = 100.00
  Vs,j2 is multiplied by   Col,j2 = 1.00
    s/d = 0.13157895
  Vs,core = Vs,c1 + Vs,c2 = 107231.957
  Vs,c1 = 0.00 is calculated for section web core, with:
    d = 200.00
    Av = 100530.965
    fy = 444.44
    s = 250.00
  Vs,c1 is multiplied by   Col,c1 = 0.00
    s/d = 1.25
  Vs,c2 = 107231.957 is calculated for section flange core, with:
    d = 600.00
    Av = 100530.965
    fy = 444.44
    s = 250.00
  Vs,c2 is multiplied by   Col,c2 = 1.00
    s/d = 0.41666667
  Vf ((11-3)-(11.4), ACI 440) = 477918.239
     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) = 907.00
  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 <= 1.1791E+006
    bw = 450.00

Calculation of Shear Strength at edge 2, Vr2 = 1.6269E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 1.6269E+006
  knl = 1 (zero step-static loading)

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

= 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 0.62124232
Vu = 4.4410684E-008
d = 0.8*h = 760.00
Nu = 20792.011
Ag = 427500.00
From (11.5.4.8), ACI 318-14: Vs = Vs,jacket + Vs,core = 1.0846E+006
where:
Vs,jacket = Vs,j1 + Vs,j2 = 977392.20
Vs,j1 = 314161.779 is calculated for section web jacket, with:
d = 360.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs,j1 is multiplied by Col,j1 = 1.00
s/d = 0.27777778
Vs,j2 = 663230.422 is calculated for section flange jacket, with:
d = 760.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs,j2 is multiplied by Col,j2 = 1.00
s/d = 0.13157895
Vs,core = Vs,c1 + Vs,c2 = 107231.957
Vs,c1 = 0.00 is calculated for section web core, with:
d = 200.00
Av = 100530.965
fy = 444.44
s = 250.00
Vs,c1 is multiplied by Col,c1 = 0.00
s/d = 1.25
Vs,c2 = 107231.957 is calculated for section flange core, with:
d = 600.00
Av = 100530.965
fy = 444.44
s = 250.00
Vs,c2 is multiplied by Col,c2 = 1.00
s/d = 0.41666667
Vf ((11-3)-(11.4), ACI 440) = 477918.239
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) = 907.00
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 <= 1.1791E+006
bw = 450.00

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

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

Constant Properties

Knowledge Factor,   = 0.90
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
Max Height, Hmax = 750.00
Min Height, Hmin = 450.00
Max Width, Wmax = 950.00
Min Width, Wmin = 450.00
Eccentricity, Ecc = 250.00
Jacket Thickness, tj = 100.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lb = 300.00
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 = 98911.173
Shear Force, V2 = 6880.904
Shear Force, V3 = 14.24369
Axial Force, F = -21249.44
Longitudinal Reinforcement Area Distribution (in 2 divisions)
        -Tension: Aslt = 0.00
     -Compression: Aslc = 6691.592
Longitudinal Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten = 1539.38
     -Compression: Asl,com = 1539.38
        -Middle: Asl,mid = 3612.832
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
        -Tension: Asl,ten,jacket = 1231.504
     -Compression: Asl,com,jacket = 1231.504
        -Middle: Asl,mid,jacket = 2689.203

Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
    -Tension: Asl,ten,core = 307.8761
   -Compression: Asl,com,core = 307.8761
    -Middle: Asl,mid,core = 923.6282
Mean Diameter of Tension Reinforcement, DbL = 16.57143

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = * θu = 0.03806135
θu = θy + θp = 0.04229038

 - Calculation of θy -

θy = (My*Ls/3)/Eleff = 0.00029038 ((4.29),Biskinis Phd))
My = 7.6198E+008
Ls = M/V (with Ls > 0.1*L and Ls < 2*L) = 300.00
From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 2.6241E+014
  factor = 0.30
   Ag = 562500.00
   Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333
   N = 21249.44
  Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 8.7468E+014

Calculation of Yielding Moment My

Calculation of θy and My according to Annex 7 -

θy = Min(θy_ten, θy_com)
θy_ten = 2.6145517E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 352.1657
  d = 907.00
   y = 0.2574726
  A = 0.01654277
  B = 0.00873394
  with pt = 0.0037716
    pc = 0.0037716
    pv = 0.00885172
    N = 21249.44
    b = 450.00
     δ" = 0.04740904
θy_comp = 9.5510798E-006
with fc* (12.3, (ACI 440)) = 33.253
  fc = 33.00
  fl = 0.43533893
  b = bmax = 950.00
  h = hmax = 750.00
  Ag = 0.5625
    ρg = pt + pc + pv = 0.01639493
   rc = 40.00
   Ae/Ac = 0.29742395
   Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
  effective strain from (12.5) and (12.12), efe = 0.004
   fu = 0.01
  Ef = 64828.00
  Ec = 26999.444
   y = 0.25591086
  A = 0.01627751
  B = 0.0085861
  with Es = 200000.00

Calculation of ratio lb/ld

```
------------------------------------------------------------
Lap Length: ld/ld,min = 0.38756552
lb = 300.00
ld = 774.0627
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
     = 1
   db = 16.66667
   Mean strength value of all re-bars: fy = 524.4464
   Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 26.93333, but fc^0.5 <=
8.3 MPa (22.5.3.1, ACI 318-14)
     t = 1.00
     s = 0.80
     e = 1.00
   cb = 25.00
   Ktr = 1.37392
    Atr = Min(Atr_x,Atr_y) = 257.6106
    where Atr_x, Atr_y are the sum of the area of all stirrup legs along X and Y loxal axis
    s = Max(s_external,s_internal) = 250.00
    n = 30.00


------------------------------------------------------------
 - 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/VCol0E = 0.39733369
   d = d_external = 907.00
   s = s_external = 0.00
 -  t =  s1 +  s2 + 2*tf/bw*(ffe/fs) = 0.00638555
   jacket:  s1 = Av1*Lstir1/(s1*Ag) = 0.00357443
        Av1 = 78.53982, is the area of every stirrup parallel to loading (shear) direction
        Lstir1 = 2560.00, is the total Length of all stirrups parallel to loading (shear) direction
        s1 = 100.00
   core:   s2 = Av2*Lstir2/(s2*Ag) = 0.00070345
        Av2 = 50.26548, is the area of every stirrup parallel to loading (shear) direction
        Lstir2 = 1968.00, is the total Length of all stirrups parallel to loading (shear) direction
        s2 = 250.00
   The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
   where  f = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises  f to steel strength
   All these variables have already been given in Shear control ratio calculation.
   For the normalisation fs of jacket is used.
     NUD = 21249.44
     Ag = 562500.00
     f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 26.93333
     fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein =
529.9972
     fytE = (fy_ext_Trans_Reinf*  s1+fy_int_Trans_Reinf*  s2)/(  s1+  s2) = 537.2876
pl = Area_Tot_Long_Rein/(b*d) = 0.01639493
   b = 450.00
   d = 907.00
     f'cE = 26.93333
------------------------------------------------------------
End Of Calculation of Chord Rotation Capacity for element: column JTC1 of floor 1
At local axis: 3
Integration Section: (b)


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