

Detailed Member Calculations

Units: N&mm

Regulation: ASCE 41-17

Calculation No. 1

beam B1, Floor 1

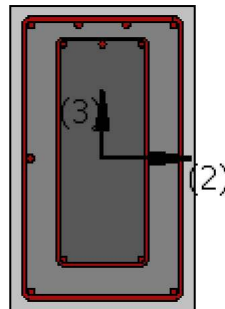
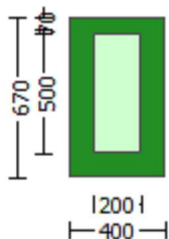
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: Start

Local Axis: (2)



Start Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 0.87$

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, $f_c = f_{c_lower_bound} = 20.00$

New material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$

Concrete Elasticity, $E_c = 25742.96$
Steel Elasticity, $E_s = 200000.00$
Existing Column
Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$
Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 420.00$
Concrete Elasticity, $E_c = 23025.204$
Steel Elasticity, $E_s = 200000.00$
External Height, $H = 670.00$
External Width, $W = 400.00$
Internal Height, $H = 500.00$
Internal Width, $W = 200.00$
Cover Thickness, $c = 25.00$
Element Length, $L = 3000.00$
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length ($l_o/l_{ou,min} = l_b/l_d \geq 1$)
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, $M_a = 1.6825104E-011$
Shear Force, $V_a = 1.3365595E-014$
EDGE -B-
Bending Moment, $M_b = 2.3137405E-011$
Shear Force, $V_b = -1.3365595E-014$
BOTH EDGES
Axial Force, $F = -7187.067$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{st} = 709.9999$
-Compression: $A_{sc} = 1668.186$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{st,ten} = 911.0619$
-Compression: $A_{st,com} = 911.0619$
-Middle: $A_{st,mid} = 556.0619$
Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 15.20$

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = V_n = 274161.749$
 $V_n ((22.5.1.1), ACI 318-14) = 315128.448$

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f^*V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 147576.839$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot Area_jacket + f'_{c_core} \cdot Area_core) / Area_section = 18.50746$, but $f_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $p_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 670.00$
 $d = 320.00$
 $V_u \cdot d / M_u < 1 = 0.00$
 $M_u = 1.6825104E-011$
 $V_u = 1.3365595E-014$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 167551.608$
 $V_{s1} = 167551.608$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 500.00$
 $s = 150.00$

Vs1 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

Vs2 = 0.00 is calculated for core, with:

$d = 160.00$

$A_v = 100530.965$

$f_y = 420.00$

$s = 300.00$

Vs2 is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)

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

From (11-11), ACI 440: $V_s + V_f \leq 612724.122$

End Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (a)

Calculation No. 2

beam B1, Floor 1

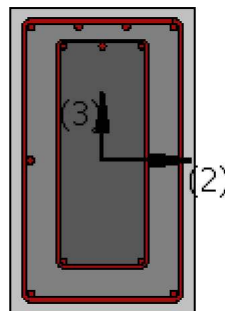
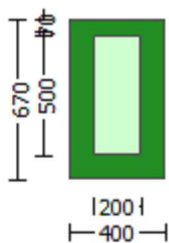
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (θ)

Edge: Start

Local Axis: (2)



Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\phi = 0.87$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

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Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 24.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 525.00
Concrete Elasticity, Ec = 23025.204
Steel Elasticity, Es = 200000.00
#####
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 781.25
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 656.25
#####
External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou, min >= 1)
No FRP Wrapping
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Stepwise Properties
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At local axis: 3
EDGE -A-
Shear Force, Va = 9840.634
EDGE -B-
Shear Force, Vb = 9840.632
BOTH EDGES
Axial Force, F = -2309.833
Longitudinal Reinforcement Area Distribution (in 2 divisions)
  -Tension: Ast = 709.9999
  -Compression: Asc = 1668.186
Longitudinal Reinforcement Area Distribution (in 3 divisions)
  -Tension: Ast,ten = 709.9999
  -Compression: Asc,com = 1266.062
  -Middle: Asc,mid = 402.1239
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Calculation of Shear Capacity ratio , Ve/Vr = 0.92480584
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln ± vu*ln/2 = 535287.788
with
Mpr1 = Max(Mu1+ , Mu1-) = 7.8817E+008
  Mu1+ = 4.6479E+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- = 7.8817E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment
  direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 7.8817E+008
  Mu2+ = 4.6479E+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- = 7.8817E+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
and
± vu*ln = (|V1| + |V2|)/2
with

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V1 = 9840.634, is the shear force acting at edge 1 for the the static loading combination
V2 = 9840.632, is the shear force acting at edge 2 for the the static loading combination

Calculation of Mu1+

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

$$\phi_u = 5.6369735E-005$$

$$M_u = 4.6479E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.000307$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$\phi_{co} \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_{co}) = 0.0053097$$

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

$$\text{From (5.4b), TBDY: } \phi_u = 0.0053097$$

$$\phi_{we} \text{ (5.4c)} = 0.00204688$$

$$\phi_{ase} \text{ ((5.4d), TBDY)} = (\phi_{ase1} * A_{ext} + \phi_{ase2} * A_{int}) / A_{sec} = 0.14776895$$

$$\phi_{ase1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$\phi_{ase2} = \text{Max}(\phi_{ase1}, \phi_{ase2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$\phi_{psh,min} * F_{ywe} = \text{Min}(\phi_{psh,x} * F_{ywe}, \phi_{psh,y} * F_{ywe}) = 1.38519$$

Expression ((5.4d), TBDY) for $\phi_{psh,min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\phi_{psh,x} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{psh2} * F_{ywe2} = 2.45559$$

$$\phi_{ps1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$\phi_{ps2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$\phi_{psh,y} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{psh2} * F_{ywe2} = 1.38519$$

$$\phi_{ps1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$\phi_{ps2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_{cc} = 0.002$$

$$\phi_c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

```

ft1 = 872.4558
fy1 = 727.0465
su1 = 0.032
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb = 1.00
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.
    with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 727.0465
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 882.7854
fy2 = 735.6545
su2 = 0.032
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 1.00
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 735.6545
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 937.50
fyv = 781.25
suv = 0.032
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb = 1.00
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 781.25
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06860752
2 = Asl,com/(b*d)*(fs2/fc) = 0.12378842
v = Asl,mid/(b*d)*(fsv/fc) = 0.04175429
and confined core properties:
b = 340.00
d = 597.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.08477074
    2 = Asl,com/(b*d)*(fs2/fc) = 0.15295169
    v = Asl,mid/(b*d)*(fsv/fc) = 0.05159117
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.09460844
Mu = MRc (4.14) = 4.6479E+008

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$$u = su(4.1) = 5.6369735E-005$$

Calculation of ratio l_b/d

Adequate Lap Length: $l_b/d \geq 1$

Calculation of μ_1 -

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

$$u = 6.0907698E-005$$

$$\mu = 7.8817E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.000307$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$\alpha(5A.5, TBDY) = 0.002$$

$$\text{Final value of } \mu: \mu^* = \text{shear_factor} * \text{Max}(\mu, \alpha) = 0.0053097$$

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

$$\text{From (5.4b), TBDY: } \mu = 0.0053097$$

$$\mu(5.4c) = 0.00204688$$

$$\alpha((5.4d), TBDY) = (\alpha_1 * A_{ext} + \alpha_2 * A_{int}) / A_{sec} = 0.14776895$$

$$\alpha_1 = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$\alpha_2 = \text{Max}(\alpha_1, \alpha_2) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$\mu_{sh,min} * F_{ywe} = \text{Min}(\mu_{sh,x} * F_{ywe}, \mu_{sh,y} * F_{ywe}) = 1.38519$$

Expression ((5.4d), TBDY) for $\mu_{sh,min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\mu_{sh,x} * F_{ywe} = \mu_{sh1} * F_{ywe1} + \mu_{sh2} * F_{ywe2} = 2.45559$$

$$\mu_{sh1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$\mu_{sh2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$\mu_{sh,y} * F_{ywe} = \mu_{sh1} * F_{ywe1} + \mu_{sh2} * F_{ywe2} = 1.38519$$

$$\mu_{sh1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$\mu_{sh2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

```

fce = 30.00
From ((5A.5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.0025
sh1 = 0.008
ft1 = 882.7854
fy1 = 735.6545
su1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 735.6545
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 872.4558
fy2 = 727.0465
su2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 727.0465
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 937.50
fyv = 781.25
suv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 781.25
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.12378842
2 = Asl,com/(b*d)*(fs2/fc) = 0.06860752
v = Asl,mid/(b*d)*(fsv/fc) = 0.04175429
and confined core properties:
b = 340.00
d = 597.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.15295169
2 = Asl,com/(b*d)*(fs2/fc) = 0.08477074
v = Asl,mid/(b*d)*(fsv/fc) = 0.05159117
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)

```



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---->
v < vs,y2 - LHS eq.(4.5) is not satisfied
---->
v < vs,c - RHS eq.(4.5) is satisfied
---->
su (4.8) = 0.16206515
Mu = MRc (4.15) = 7.8817E+008
u = su (4.1) = 6.0907698E-005

```

Calculation of ratio lb/d

Adequate Lap Length: lb/d >= 1

Calculation of Mu2+

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 5.6369735E-005
Mu = 4.6479E+008

with full section properties:

```

b = 400.00
d = 627.00
d' = 43.00
v = 0.000307
N = 2309.833
fc = 30.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.0053097
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0053097
we (5.4c) = 0.00204688
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.14776895
ase1 = 0.14776895
bo_1 = 340.00
ho_1 = 610.00
bi2_1 = 975400.00
ase2 = Max(ase1,ase2) = 0.14776895
bo_2 = 192.00
ho_2 = 492.00
bi2_2 = 557856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.38519
Expression ((5.4d), TBDY) for psh,min*Fywe has been multiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

```

```

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.45559
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 500.00

```

```

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.38519
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00

```

$$h2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

$$\text{From } ((5.5), \text{TBDY}), \text{TBDY: } c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 872.4558$$

$$fy1 = 727.0465$$

$$su1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/ld = 1.00$$

$$su1 = 0.4 * esu1_{nominal} ((5.5), \text{TBDY}) = 0.032$$

$$\text{From table 5A.1, TBDY: } esu1_{nominal} = 0.08,$$

For calculation of $esu1_{nominal}$ and $y1, sh1, ft1, fy1$, it is considered
characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.

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

$$\text{with } fs1 = (fs_{jacket} * Asl, \text{ten}, \text{jacket} + fs_{core} * Asl, \text{ten}, \text{core}) / Asl, \text{ten} = 727.0465$$

$$\text{with } Es1 = (Es_{jacket} * Asl, \text{ten}, \text{jacket} + Es_{core} * Asl, \text{ten}, \text{core}) / Asl, \text{ten} = 200000.00$$

$$y2 = 0.0025$$

$$sh2 = 0.008$$

$$ft2 = 882.7854$$

$$fy2 = 735.6545$$

$$su2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/lb, \min = 1.00$$

$$su2 = 0.4 * esu2_{nominal} ((5.5), \text{TBDY}) = 0.032$$

$$\text{From table 5A.1, TBDY: } esu2_{nominal} = 0.08,$$

For calculation of $esu2_{nominal}$ and $y2, sh2, ft2, fy2$, it is considered
characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.

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

$$\text{with } fs2 = (fs_{jacket} * Asl, \text{com}, \text{jacket} + fs_{core} * Asl, \text{com}, \text{core}) / Asl, \text{com} = 735.6545$$

$$\text{with } Es2 = (Es_{jacket} * Asl, \text{com}, \text{jacket} + Es_{core} * Asl, \text{com}, \text{core}) / Asl, \text{com} = 200000.00$$

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 937.50$$

$$fyv = 781.25$$

$$suv = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/ld = 1.00$$

$$suv = 0.4 * esuv_{nominal} ((5.5), \text{TBDY}) = 0.032$$

$$\text{From table 5A.1, TBDY: } esuv_{nominal} = 0.08,$$

considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
For calculation of $esuv_{nominal}$ and yv, shv, ftv, fyv , it is considered
characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.

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

$$\text{with } fsv = (fs_{jacket} * Asl, \text{mid}, \text{jacket} + fs_{mid} * Asl, \text{mid}, \text{core}) / Asl, \text{mid} = 781.25$$

$$\text{with } Esv = (Es_{jacket} * Asl, \text{mid}, \text{jacket} + Es_{mid} * Asl, \text{mid}, \text{core}) / Asl, \text{mid} = 200000.00$$

$$1 = Asl, \text{ten} / (b * d) * (fs1 / f_c) = 0.06860752$$

$$2 = Asl, \text{com} / (b * d) * (fs2 / f_c) = 0.12378842$$

$$v = Asl, \text{mid} / (b * d) * (fsv / f_c) = 0.04175429$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc (5A.2, \text{TBDY}) = 30.00$$

$cc(5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.08477074$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.15295169$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.05159117$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->

$su(4.9) = 0.09460844$
 $Mu = MRc(4.14) = 4.6479E+008$
 $u = su(4.1) = 5.6369735E-005$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of Mu_2 -

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

$u = 6.0907698E-005$
 $Mu = 7.8817E+008$

with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.000307$
 $N = 2309.833$
 $fc = 30.00$
 $co(5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0053097$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.0053097$
 $w_e(5.4c) = 0.00204688$
 $ase((5.4d), TBDY) = (ase1*A_{ext} + ase2*A_{int})/A_{sec} = 0.14776895$
 $ase1 = 0.14776895$
 $bo_1 = 340.00$
 $ho_1 = 610.00$
 $bi2_1 = 975400.00$
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi2_2 = 557856.00$
 $psh_{min}*F_{ywe} = \text{Min}(psh_x*F_{ywe}, psh_y*F_{ywe}) = 1.38519$
 Expression ((5.4d), TBDY) for $psh_{min}*F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh_x*F_{ywe} = psh1*F_{ywe1} + ps2*F_{ywe2} = 2.45559$
 $ps1(\text{external}) = (A_{sh1}*h1/s1)/A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir_1}*ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 670.00$
 $ps2(\text{internal}) = (A_{sh2}*h2/s2)/A_{sec} = 0.00062519$
 $A_{sh2} = A_{stir_2}*ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 500.00$

$psh_y*F_{ywe} = psh1*F_{ywe1} + ps2*F_{ywe2} = 1.38519$
 $ps1(\text{external}) = (A_{sh1}*h1/s1)/A_{sec} = 0.00156298$
 $A_{sh1} = A_{stir_1}*ns_1 = 157.0796$

No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00025008$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

 $Asec = 268000.00$
 $s1 = 150.00$
 $s2 = 300.00$
 $fyw1 = 781.25$
 $fyw2 = 656.25$
 $fce = 30.00$

From ((5.A5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$

$y1 = 0.0025$
 $sh1 = 0.008$
 $ft1 = 882.7854$
 $fy1 = 735.6545$
 $su1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lou, \min = lb/ld = 1.00$

$su1 = 0.4 \cdot esu1_nominal \text{ ((5.5), TBDY)} = 0.032$

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

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

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

with $fs1 = (fs_jacket \cdot Asl, \text{ten}, \text{jacket} + fs_core \cdot Asl, \text{ten}, \text{core}) / Asl, \text{ten} = 735.6545$

with $Es1 = (Es_jacket \cdot Asl, \text{ten}, \text{jacket} + Es_core \cdot Asl, \text{ten}, \text{core}) / Asl, \text{ten} = 200000.00$

$y2 = 0.0025$
 $sh2 = 0.008$
 $ft2 = 872.4558$
 $fy2 = 727.0465$
 $su2 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lou, \min = lb/lb, \min = 1.00$

$su2 = 0.4 \cdot esu2_nominal \text{ ((5.5), TBDY)} = 0.032$

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

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

$y2, sh2, ft2, fy2$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs2 = (fs_jacket \cdot Asl, \text{com}, \text{jacket} + fs_core \cdot Asl, \text{com}, \text{core}) / Asl, \text{com} = 727.0465$

with $Es2 = (Es_jacket \cdot Asl, \text{com}, \text{jacket} + Es_core \cdot Asl, \text{com}, \text{core}) / Asl, \text{com} = 200000.00$

$yv = 0.0025$
 $shv = 0.008$
 $ftv = 937.50$
 $fyv = 781.25$
 $suv = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lou, \min = lb/ld = 1.00$

$suv = 0.4 \cdot esuv_nominal \text{ ((5.5), TBDY)} = 0.032$

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

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

For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.

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

with $fsv = (fs_jacket \cdot Asl, \text{mid}, \text{jacket} + fs_mid \cdot Asl, \text{mid}, \text{core}) / Asl, \text{mid} = 781.25$

with $Es_v = (Es_jacket \cdot Asl, \text{mid}, \text{jacket} + Es_mid \cdot Asl, \text{mid}, \text{core}) / Asl, \text{mid} = 200000.00$

$1 = Asl, \text{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.12378842$

$2 = Asl, \text{com} / (b \cdot d) \cdot (fs2 / fc) = 0.06860752$

$v = Asl, \text{mid} / (b \cdot d) \cdot (fsv / fc) = 0.04175429$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc(5A.2, TBDY) = 30.00$$

$$cc(5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.15295169$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.08477074$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.05159117$$

Case/Assumption: Unconfined full section - Steel rupture

'satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is not satisfied

--->

$v < v_{s,c}$ - RHS eq.(4.5) is satisfied

--->

$$s_u(4.8) = 0.16206515$$

$$M_u = M_{Rc}(4.15) = 7.8817E+008$$

$$u = s_u(4.1) = 6.0907698E-005$$

Calculation of ratio l_b/d

Adequate Lap Length: $l_b/d \geq 1$

Calculation of Shear Strength $V_r = \min(V_{r1}, V_{r2}) = 578810.994$

Calculation of Shear Strength at edge 1, $V_{r1} = 578810.994$

$V_{r1} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f*V_f$ '

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

From Table (22.5.5.1), ACI 318-14: $V_c = 192813.976$

= 1 (normal-weight concrete)

Mean concrete strength: $f'_c = (f'_{c,jacket} * \text{Area}_{jacket} + f'_{c,core} * \text{Area}_{core}) / \text{Area}_{section} = 27.76119$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$$p_w = A_s / (b_w * d) = 0.00331157$$

$$A_s (\text{tension reinf.}) = 709.9999$$

$$b_w = 400.00$$

$$d = 536.00$$

$$V_u * d / M_u < 1 = 1.00$$

$$M_u = 1.1510E+006$$

$$V_u = 9840.634$$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 385997.017$

$V_{s1} = 350811.18$ is calculated for jacket, with:

$$d = 536.00$$

$$A_v = 157079.633$$

$$f_y = 625.00$$

$$s = 150.00$$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 35185.838$ is calculated for jacket, with:

$$d_2 = 400.00$$

$$A_v = 100530.965$$

$$f_y = 525.00$$

$$s = 300.00$$

V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.50$$

$$V_f ((11-3)-(11.4), \text{ACI } 440) = 0.00$$

$$\text{From } (11-11), \text{ACI } 440: V_s + V_f \leq 750430.726$$

Calculation of Shear Strength at edge 2, $V_{r2} = 578810.994$

$V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 192813.976$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot Area_jacket + f'_{c_core} \cdot Area_core) / Area_section = 27.76119$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 400.00$
 $d = 536.00$
 $V_u \cdot d / M_u < 1 = 1.00$
 $M_u = 1.1510E+006$
 $V_u = 9840.632$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 385997.017$
 $V_{s1} = 350811.18$ is calculated for jacket, with:
 $d = 536.00$
 $A_v = 157079.633$
 $f_y = 625.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 35185.838$ is calculated for jacket, with:
 $d = 400.00$
 $A_v = 100530.965$
 $f_y = 525.00$
 $s = 300.00$
 V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
 V_f ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f \leq 750430.726$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjars

Constant Properties

Knowledge Factor, $\phi = 0.87$
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 30.00$
New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$
Concrete Elasticity, $E_c = 25742.96$
Steel Elasticity, $E_s = 200000.00$
Existing Column
Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$
Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$
Concrete Elasticity, $E_c = 23025.204$
Steel Elasticity, $E_s = 200000.00$

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, $f_s = 1.25 \cdot f_{sm} = 781.25$
Existing Column
Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 656.25$

External Height, $H = 670.00$

External Width, $W = 400.00$
 Internal Height, $H = 500.00$
 Internal Width, $W = 200.00$
 Cover Thickness, $c = 25.00$
 Mean Confinement Factor overall section = 1.00
 Element Length, $L = 3000.00$
 Secondary Member
 Smooth Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Adequate Lap Length ($l_o/l_{ou}, \min \geq 1$)
 No FRP Wrapping

Stepwise Properties

At local axis: 2
 EDGE -A-
 Shear Force, $V_a = -9.0372119E-015$
 EDGE -B-
 Shear Force, $V_b = 9.0372119E-015$
 BOTH EDGES
 Axial Force, $F = -2309.833$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $As_t = 709.9999$
 -Compression: $As_c = 1668.186$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten} = 911.0619$
 -Compression: $As_{c,com} = 911.0619$
 -Middle: $As_{c,mid} = 556.0619$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.55914272$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n / 2 = 218168.257$
 with
 $M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 3.2725E+008$
 $\mu_{u1+} = 3.2725E+008$, 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
 $\mu_{u1-} = 3.2725E+008$, 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
 $M_{pr2} = \max(\mu_{u2+}, \mu_{u2-}) = 3.2725E+008$
 $\mu_{u2+} = 3.2725E+008$, 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
 $\mu_{u2-} = 3.2725E+008$, 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
 and
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$
 with
 $V_1 = -9.0372119E-015$, is the shear force acting at edge 1 for the the static loading combination
 $V_2 = 9.0372119E-015$, is the shear force acting at edge 2 for the the static loading combination

Calculation of μ_{u1+}

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

$\mu_u = 0.00010507$
 $M_u = 3.2725E+008$

with full section properties:

$b = 670.00$
 $d = 357.00$

$d' = 43.00$
 $v = 0.0003219$
 $N = 2309.833$
 $fc = 30.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of $cu^* = shear_factor * Max(cu, cc) = 0.0053097$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.0053097$
 $we (5.4c) = 0.00204688$
 $ase ((5.4d), TBDY) = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$
 $ase1 = 0.14776895$
 $bo_1 = 340.00$
 $ho_1 = 610.00$
 $bi2_1 = 975400.00$
 $ase2 = Max(ase1, ase2) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi2_2 = 557856.00$
 $psh, min * F_{ywe} = Min(psh, x * F_{ywe}, psh, y * F_{ywe}) = 1.38519$
 Expression ((5.4d), TBDY) for $psh, min * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh, x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.45559$
 $ps1 (external) = (Ash1 * h1 / s1) / A_{sec} = 0.00261799$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 670.00$
 $ps2 (internal) = (Ash2 * h2 / s2) / A_{sec} = 0.00062519$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 500.00$

$psh, y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.38519$
 $ps1 (external) = (Ash1 * h1 / s1) / A_{sec} = 0.00156298$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 (internal) = (Ash2 * h2 / s2) / A_{sec} = 0.00025008$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

$A_{sec} = 268000.00$
 $s1 = 150.00$
 $s2 = 300.00$
 $fywe1 = 781.25$
 $fywe2 = 656.25$
 $f_{ce} = 30.00$

From ((5.A5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$

$y1 = 0.0025$
 $sh1 = 0.008$
 $ft1 = 886.8103$
 $fy1 = 739.0086$
 $su1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$

$lo/lo_{u,min} = lb/ld = 1.00$

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

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

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

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

with $fs1 = (fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 739.0086$

with $Es1 = (Es_{jacket} * A_{sl,ten,jacket} + Es_{core} * A_{sl,ten,core}) / A_{sl,ten} = 200000.00$

$y2 = 0.0025$


```

sh2 = 0.008
ft2 = 886.8103
fy2 = 739.0086
su2 = 0.032
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/lb,min = 1.00
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 739.0086
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 895.9746
fyv = 746.6455
suv = 0.032
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/ld = 1.00
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 746.6455
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09382814
2 = Asl,com/(b*d)*(fs2/fc) = 0.09382814
v = Asl,mid/(b*d)*(fsv/fc) = 0.05785932
and confined core properties:
b = 610.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11251192
2 = Asl,com/(b*d)*(fs2/fc) = 0.11251192
v = Asl,mid/(b*d)*(fsv/fc) = 0.06938071
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.9) = 0.1468828
Mu = MRc (4.14) = 3.2725E+008
u = su (4.1) = 0.00010507

```

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

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

u = 0.00010507

$$\mu = 3.2725E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.0003219$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$\phi (5A.5, \text{TB DY}) = 0.002$$

$$\text{Final value of } \phi: \phi^* = \text{shear_factor} * \text{Max}(\phi_c, \phi_s) = 0.0053097$$

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

$$\text{From (5.4b), TB DY: } \phi_c = 0.0053097$$

$$\phi_s (5.4c) = 0.00204688$$

$$\phi_{se} ((5.4d), \text{TB DY}) = (\phi_{se1} * A_{ext} + \phi_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$\phi_{se1} = 0.14776895$$

$$b_{o1} = 340.00$$

$$h_{o1} = 610.00$$

$$b_{i21} = 975400.00$$

$$\phi_{se2} = \text{Max}(\phi_{se1}, \phi_{se2}) = 0.14776895$$

$$b_{o2} = 192.00$$

$$h_{o2} = 492.00$$

$$b_{i22} = 557856.00$$

$$\phi_{sh, \min} * \phi_{ywe} = \text{Min}(\phi_{sh, x} * \phi_{ywe}, \phi_{sh, y} * \phi_{ywe}) = 1.38519$$

Expression ((5.4d), TB DY) for $\phi_{sh, \min} * \phi_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\phi_{sh, x} * \phi_{ywe} = \phi_{sh1} * \phi_{ywe1} + \phi_{sh2} * \phi_{ywe2} = 2.45559$$

$$\phi_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$\phi_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$\phi_{sh, y} * \phi_{ywe} = \phi_{sh1} * \phi_{ywe1} + \phi_{sh2} * \phi_{ywe2} = 1.38519$$

$$\phi_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$\phi_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$\phi_{ywe1} = 781.25$$

$$\phi_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TB DY), TB DY: } \phi_{cc} = 0.002$$

$$\phi_c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 886.8103$$

$$fy_1 = 739.0086$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$l_o / l_{ou, \min} = l_b / l_d = 1.00$$

$$su_1 = 0.4 * esu_{1_nominal} ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } esu_{1_nominal} = 0.08,$$

For calculation of $esu_{1_nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered

characteristic value $f_{sy1} = f_{s1}/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
with $f_{s1} = (f_{s,jacket} \cdot A_{s,ten,jacket} + f_{s,core} \cdot A_{s,ten,core})/A_{s,ten} = 739.0086$
with $E_{s1} = (E_{s,jacket} \cdot A_{s,ten,jacket} + E_{s,core} \cdot A_{s,ten,core})/A_{s,ten} = 200000.00$
 $y_2 = 0.0025$
 $sh_2 = 0.008$
 $ft_2 = 886.8103$
 $fy_2 = 739.0086$
 $su_2 = 0.032$
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 1.00$
 $su_2 = 0.4 \cdot esu_{2,nominal} ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,
For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
characteristic value $f_{sy2} = f_{s2}/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
with $f_{s2} = (f_{s,jacket} \cdot A_{s,com,jacket} + f_{s,core} \cdot A_{s,com,core})/A_{s,com} = 739.0086$
with $E_{s2} = (E_{s,jacket} \cdot A_{s,com,jacket} + E_{s,core} \cdot A_{s,com,core})/A_{s,com} = 200000.00$
 $y_v = 0.0025$
 $sh_v = 0.008$
 $ft_v = 895.9746$
 $fy_v = 746.6455$
 $su_v = 0.032$
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 1.00$
 $su_v = 0.4 \cdot esu_{v,nominal} ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esu_{v,nominal} = 0.08$,
considering characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY
For calculation of $esu_{v,nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
with $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core})/A_{s,mid} = 746.6455$
with $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core})/A_{s,mid} = 200000.00$
 $1 = A_{s,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.09382814$
 $2 = A_{s,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.09382814$
 $v = A_{s,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.05785932$
and confined core properties:
 $b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 30.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{s,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.11251192$
 $2 = A_{s,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.11251192$
 $v = A_{s,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.06938071$
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)
--->
 $v < v_{s,c}$ - RHS eq.(4.5) is satisfied
--->
 $su (4.9) = 0.1468828$
 $Mu = MR_c (4.14) = 3.2725E+008$
 $u = su (4.1) = 0.00010507$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of Mu_{2+}

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

$$\phi_u = 0.00010507$$

$$\mu = 3.2725 \times 10^8$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$\nu = 0.0003219$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$\alpha_{sc} (5A.5, \text{TBDY}) = 0.002$$

$$\text{Final value of } \phi_{cu}: \phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.0053097$$

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

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.0053097$$

$$\phi_{we} (5.4c) = 0.00204688$$

$$\alpha_{se} ((5.4d), \text{TBDY}) = (\alpha_{se1} * A_{ext} + \alpha_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$\alpha_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$\alpha_{se2} = \text{Max}(\alpha_{se1}, \alpha_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$\phi_{psh,min} * F_{ywe} = \text{Min}(\phi_{psh,x} * F_{ywe}, \phi_{psh,y} * F_{ywe}) = 1.38519$$

Expression ((5.4d), TBDY) for $\phi_{psh,min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\phi_{psh,x} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{psh2} * F_{ywe2} = 2.45559$$

$$\phi_{psh1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$\phi_{psh2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$\phi_{psh,y} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{psh2} * F_{ywe2} = 1.38519$$

$$\phi_{psh1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$\phi_{psh2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_{cc} = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 886.8103$$

$$fy_1 = 739.0086$$

$$su_1 = 0.032$$

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

```

Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 739.0086
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 886.8103
fy2 = 739.0086
su2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 739.0086
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 895.9746
fyv = 746.6455
suv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 746.6455
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09382814
2 = Asl,com/(b*d)*(fs2/fc) = 0.09382814
v = Asl,mid/(b*d)*(fsv/fc) = 0.05785932
and confined core properties:
b = 610.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11251192
2 = Asl,com/(b*d)*(fs2/fc) = 0.11251192
v = Asl,mid/(b*d)*(fsv/fc) = 0.06938071
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.9) = 0.1468828
Mu = MRc (4.14) = 3.2725E+008
u = su (4.1) = 0.00010507

```

Calculation of ratio lb/ld

Adequate Lap Length: $l_b/d \geq 1$

Calculation of μ_2 -

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

$$\mu = 0.00010507$$

$$\mu = 3.2725 \times 10^{-8}$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.0003219$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$\alpha (5A.5, \text{TB DY}) = 0.002$$

$$\text{Final value of } \mu: \mu^* = \text{shear_factor} * \text{Max}(\mu, \alpha) = 0.0053097$$

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

$$\text{From (5.4b), TB DY: } \mu = 0.0053097$$

$$\mu_e (5.4c) = 0.00204688$$

$$\alpha_e ((5.4d), \text{TB DY}) = (\alpha_1 * A_{ext} + \alpha_2 * A_{int}) / A_{sec} = 0.14776895$$

$$\alpha_1 = 0.14776895$$

$$b_{o1} = 340.00$$

$$h_{o1} = 610.00$$

$$b_{i1} = 975400.00$$

$$\alpha_2 = \text{Max}(\alpha_1, \alpha_2) = 0.14776895$$

$$b_{o2} = 192.00$$

$$h_{o2} = 492.00$$

$$b_{i2} = 557856.00$$

$$\mu_{sh, \min} * F_{ywe} = \text{Min}(\mu_{sh, x} * F_{ywe}, \mu_{sh, y} * F_{ywe}) = 1.38519$$

Expression ((5.4d), TB DY) for $\mu_{sh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\mu_{sh, x} * F_{ywe} = \mu_{sh1} * F_{ywe1} + \mu_{sh2} * F_{ywe2} = 2.45559$$

$$\mu_{sh1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$h_1 = 670.00$$

$$\mu_{sh2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir2} * n_{s2} = 100.531$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$$h_2 = 500.00$$

$$\mu_{sh, y} * F_{ywe} = \mu_{sh1} * F_{ywe1} + \mu_{sh2} * F_{ywe2} = 1.38519$$

$$\mu_{sh1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$h_1 = 400.00$$

$$\mu_{sh2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir2} * n_{s2} = 100.531$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TB DY), TB DY: } \alpha = 0.002$$

$$\alpha = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$s_{h1} = 0.008$$

```

ft1 = 886.8103
fy1 = 739.0086
su1 = 0.032
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb = 1.00
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 739.0086
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 886.8103
fy2 = 739.0086
su2 = 0.032
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 1.00
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 739.0086
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 895.9746
fyv = 746.6455
suv = 0.032
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb = 1.00
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 746.6455
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09382814
2 = Asl,com/(b*d)*(fs2/fc) = 0.09382814
v = Asl,mid/(b*d)*(fsv/fc) = 0.05785932
and confined core properties:
b = 610.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.11251192
    2 = Asl,com/(b*d)*(fs2/fc) = 0.11251192
    v = Asl,mid/(b*d)*(fsv/fc) = 0.06938071
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.9) = 0.1468828
Mu = MRc (4.14) = 3.2725E+008

```

$$u = su(4.1) = 0.00010507$$

Calculation of ratio l_b/d

Adequate Lap Length: $l_b/d \geq 1$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 390183.487$

Calculation of Shear Strength at edge 1, $V_{r1} = 390183.487$
 $V_{r1} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f^*V_f$ '
 where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 180743.977$
 $= 1$ (normal-weight concrete)
 Mean concrete strength: $fc' = (fc'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + fc'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 27.76119$, but $fc'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $pw = A_s / (bw \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $bw = 670.00$
 $d = 320.00$
 $V_u \cdot d / Mu < 1 = 0.00$
 $Mu = 6.8565666E-012$
 $V_u = 9.0372119E-015$
 From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 209439.51$
 $V_{s1} = 209439.51$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 625.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17, 10.3.4)
 $V_{s2} = 0.00$ is calculated for jacket, with:
 $d_2 = 160.00$
 $A_v = 100530.965$
 $f_y = 525.00$
 $s = 300.00$
 V_{s2} is considered 0 ($s > d$, according to ASCE 41-17, 10.3.4)
 V_f ((11-3)-(11.4), ACI 440) = 0.00
 From (11-11), ACI 440: $V_s + V_f \leq 750430.726$

Calculation of Shear Strength at edge 2, $V_{r2} = 390183.487$
 $V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f^*V_f$ '
 where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 180743.977$
 $= 1$ (normal-weight concrete)
 Mean concrete strength: $fc' = (fc'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + fc'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 27.76119$, but $fc'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $pw = A_s / (bw \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $bw = 670.00$
 $d = 320.00$
 $V_u \cdot d / Mu < 1 = 0.00$
 $Mu = 2.0256286E-011$
 $V_u = 9.0372119E-015$
 From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 209439.51$
 $V_{s1} = 209439.51$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 625.00$

s = 150.00

Vs1 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

Vs2 = 0.00 is calculated for jacket, with:

d = 160.00

Av = 100530.965

fy = 525.00

s = 300.00

Vs2 is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)

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

From (11-11), ACI 440: Vs + Vf <= 750430.726

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 0.87$

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, $f_c = f_{cm} = 30.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_b/l_d \geq 1$)

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 5.6604E+006$

Shear Force, $V_2 = 1.3365595E-014$

Shear Force, $V_3 = 4044.385$

Axial Force, $F = -7187.067$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 709.9999$

-Compression: $As_c = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{l,ten} = 709.9999$

-Compression: $As_{l,com} = 1266.062$

-Middle: $As_{l,mid} = 402.1239$

Longitudinal External Reinforcement Area Distribution (in 3 divisions)

-Tension: $Asl,ten,jacket = 402.1239$
-Compression: $Asl,com,jacket = 804.2477$
-Middle: $Asl,mid,jacket = 402.1239$

Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)

-Tension: $Asl,ten,core = 307.8761$
-Compression: $Asl,com,core = 461.8141$
-Middle: $Asl,mid,core = 0.00$

Mean Diameter of Tension Reinforcement, $DbL = 15.00$

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u,R = * u = 0.01026707$
 $u = y + p = 0.01180123$

- Calculation of y -

$y = (My*Ls/3)/Eleff = 0.00180123$ ((4.29),Biskinis Phd))
 $My = 2.9231E+008$
 $Ls = M/V$ (with $Ls > 0.1*L$ and $Ls < 2*L$) = 1399.581
From table 10.5, ASCE 41_17: $Eleff = 0.3*Ec*Ig = 7.5708E+013$

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$
 $y_{ten} = 5.8234894E-006$
with $fy = 625.00$
 $d = 627.00$
 $y = 0.18846591$
 $A = 0.00953075$
 $B = 0.00408216$
with $pt = 0.00283094$
 $pc = 0.00504809$
 $pv = 0.00160336$
 $N = 7187.067$
 $b = 400.00$
 $" = 0.06858054$
 $y_{comp} = 1.7825671E-005$
with $fc = 27.76119$
 $Ec = 25742.96$
 $y = 0.18768166$
 $A = 0.00941409$
 $B = 0.0040338$
with $Es = 200000.00$

Calculation of ratio lb/ld

Adequate Lap Length: $lb/ld \geq 1$

- Calculation of p -

From table 10-7: $p = 0.01$

with:

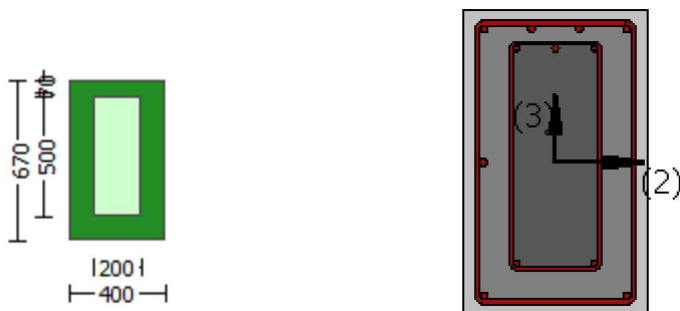
- Condition i occurred
Beam controlled by flexure: $Vp/Vo \leq 1$
shear control ratio $Vp/Vo = 0.92480584$
- Transverse Reinforcement: C
- Stirrup Spacing $\leq d/3$
- Low ductility demand, $y < 2$ (table 10-6, ASCE 41-17)
 $= 5.9864941E-005$

- Stirrup Spacing $\leq d/2$
 $d = d_{\text{external}} = 627.00$
 $s = s_{\text{external}} = 150.00$
- Strength provided by hoops $V_s < 3/4 \cdot \text{design Shear}$
 $V_s = 421182.855$, already given in calculation of shear control ratio
 $\text{design Shear} = 4044.385$
- (-)/ $\rho_{\text{bal}} = -0.3178459$
 $\rho = A_{\text{st}}/(b_w \cdot d) = 0.00283094$
 $\text{Tension Reinf Area: } A_{\text{st}} = 709.9999$
 $\rho' = A_{\text{sc}}/(b_w \cdot d) = 0.00665146$
 $\text{Compression Reinf Area: } A_{\text{sc}} = 1668.186$
 $\text{From (B-1), ACI 318-11: } \rho_{\text{bal}} = 0.01202003$
 $\rho_c = (\rho_c \cdot \text{jacket} \cdot \text{Area}_{\text{jacket}} + \rho_c \cdot \text{core} \cdot \text{Area}_{\text{core}}) / \text{section_area} = 27.76119$
 $\rho_y = \rho_y \cdot \text{jacket_bars} = 625.00$
 $\text{From 10.2.7.3, ACI 318-11: } \rho_1 = 0.65$
 $\text{From fig R10.3.3, ACI 318-11 (Ence 454, too): } 87000 / (87000 + \rho_y) = c_b/d_t = 0.003 / (0.003 + \rho_y) = 0.48979592$
 $\rho_y = 0.003125$
- $V/(b_w \cdot d \cdot \rho_c^{0.5}) = 0.03685777$, NOTE: units in lb & in
 $b_w = 400.00$

End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1
 At local axis: 2
 Integration Section: (a)

Calculation No. 3

beam B1, Floor 1
 Limit State: Operational Level (data interpolation between analysis steps 1 and 2)
 Analysis: Uniform +X
 Check: Shear capacity V_{Rd}
 Edge: Start
 Local Axis: (3)



Start Of Calculation of Shear Capacity for element: beam JB1 of floor 1
 At local axis: 3

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\phi = 0.87$

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, $f_c = f_{c_lower_bound} = 20.00$

New material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 420.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_o/l_{o,min} = l_b/l_d \geq 1$)

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 5.6604E+006$

Shear Force, $V_a = 4044.385$

EDGE -B-

Bending Moment, $M_b = 1.1729E+007$

Shear Force, $V_b = 15636.882$

BOTH EDGES

Axial Force, $F = -7187.067$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{st} = 709.9999$

-Compression: $A_{sc} = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{st,ten} = 709.9999$

-Compression: $A_{st,com} = 1266.062$

-Middle: $A_{st,mid} = 402.1239$

Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 15.00$

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = \phi V_n = 401067.322$

V_n ((22.5.1.1), ACI 318-14) = 460996.922

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + \phi V_f$ '

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

From Table (22.5.5.1), ACI 318-14: $V_c = 152199.308$

= 1 (normal-weight concrete)

Mean concrete strength: $f'_c = (f'_c_jacket * Area_jacket + f'_c_core * Area_core) / Area_section = 18.50746$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$\rho_w = A_s / (b_w * d) = 0.00331157$

A_s (tension reinf.) = 709.9999

b_w = 400.00

d = 536.00

$V_u \cdot d / M_u < 1 = 0.38297175$

M_u = 5.6604E+006

V_u = 4044.385

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 308797.614$

$V_{s1} = 280648.944$ is calculated for jacket, with:

d = 536.00

A_v = 157079.633

f_y = 500.00

s = 150.00

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 28148.67$ is calculated for core, with:

d = 400.00

A_v = 100530.965

f_y = 420.00

s = 300.00

V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.50$

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

From (11-11), ACI 440: $V_s + V_f \leq 612724.122$

End Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (a)

Calculation No. 4

beam B1, Floor 1

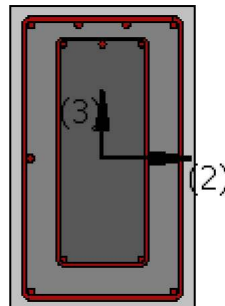
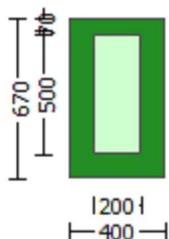
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (μ)

Edge: Start

Local Axis: (3)



Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 0.87$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

#####

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, $f_s = 1.25 \cdot f_{sm} = 781.25$

Existing Column

Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 656.25$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_o/l_{ou}, \min \geq 1$)

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = 9840.634$

EDGE -B-

Shear Force, $V_b = 9840.632$

BOTH EDGES

Axial Force, $F = -2309.833$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 709.9999$

-Compression: $As_c = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten} = 709.9999$

-Compression: $As_{c,com} = 1266.062$

-Middle: $As_{l,mid} = 402.1239$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.92480584$

Member Controlled by Flexure ($V_e/V_r < 1$)

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 535287.788$

with

$M_{pr1} = \max(M_{u1+}, M_{u1-}) = 7.8817E+008$

Mu1+ = 4.6479E+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- = 7.8817E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination

Mpr2 = Max(Mu2+ , Mu2-) = 7.8817E+008

Mu2+ = 4.6479E+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- = 7.8817E+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

and

$\pm v_u \cdot l_n = (|V1| + |V2|)/2$

with

V1 = 9840.634, is the shear force acting at edge 1 for the the static loading combination

V2 = 9840.632, is the shear force acting at edge 2 for the the static loading combination

Calculation of Mu1+

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

$\phi_u = 5.6369735E-005$

Mu = 4.6479E+008

with full section properties:

b = 400.00

d = 627.00

d' = 43.00

v = 0.000307

N = 2309.833

fc = 30.00

co (5A.5, TBDY) = 0.002

Final value of ϕ_u : $\phi_u^* = \text{shear_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.0053097$

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

From (5.4b), TBDY: $\phi_u = 0.0053097$

we (5.4c) = 0.00204688

ase ((5.4d), TBDY) = $(ase1 \cdot A_{ext} + ase2 \cdot A_{int}) / A_{sec} = 0.14776895$

ase1 = 0.14776895

bo_1 = 340.00

ho_1 = 610.00

bi2_1 = 975400.00

ase2 = Max(ase1, ase2) = 0.14776895

bo_2 = 192.00

ho_2 = 492.00

bi2_2 = 557856.00

psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.38519

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

 $psh_x \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 2.45559$

ps1 (external) = $(Ash1 \cdot h1 / s1) / A_{sec} = 0.00261799$

Ash1 = Astir_1*ns_1 = 157.0796

No stirrups, ns_1 = 2.00

h1 = 670.00

ps2 (internal) = $(Ash2 \cdot h2 / s2) / A_{sec} = 0.00062519$

Ash2 = Astir_2*ns_2 = 100.531

No stirrups, ns_2 = 2.00

h2 = 500.00

 $psh_y \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 1.38519$

ps1 (external) = $(Ash1 \cdot h1 / s1) / A_{sec} = 0.00156298$

Ash1 = Astir_1*ns_1 = 157.0796

No stirrups, ns_1 = 2.00

h1 = 400.00

ps2 (internal) = $(Ash2 \cdot h2 / s2) / A_{sec} = 0.00025008$

Ash2 = Astir_2*ns_2 = 100.531

No stirrups, ns_2 = 2.00

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

$$\text{From } ((5A.5), \text{TB DY}), \text{TB DY: } c_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 872.4558$$

$$fy_1 = 727.0465$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/ld = 1.00$$

$$su_1 = 0.4 * esu_1 \text{ nominal } ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } esu_1 \text{ nominal} = 0.08,$$

For calculation of $esu_1 \text{ nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered
characteristic value $fsy_1 = fs_1/1.2$, from table 5.1, TB DY.

$$y_1, sh_1, ft_1, fy_1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs_1 = (fs_{jacket} * Asl, \text{ten, jacket} + fs_{core} * Asl, \text{ten, core}) / Asl, \text{ten} = 727.0465$$

$$\text{with } Es_1 = (Es_{jacket} * Asl, \text{ten, jacket} + Es_{core} * Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$$

$$y_2 = 0.0025$$

$$sh_2 = 0.008$$

$$ft_2 = 882.7854$$

$$fy_2 = 735.6545$$

$$su_2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/lb, \min = 1.00$$

$$su_2 = 0.4 * esu_2 \text{ nominal } ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } esu_2 \text{ nominal} = 0.08,$$

For calculation of $esu_2 \text{ nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TB DY.

$$y_1, sh_1, ft_1, fy_1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs_2 = (fs_{jacket} * Asl, \text{com, jacket} + fs_{core} * Asl, \text{com, core}) / Asl, \text{com} = 735.6545$$

$$\text{with } Es_2 = (Es_{jacket} * Asl, \text{com, jacket} + Es_{core} * Asl, \text{com, core}) / Asl, \text{com} = 200000.00$$

$$y_v = 0.0025$$

$$sh_v = 0.008$$

$$ft_v = 937.50$$

$$fy_v = 781.25$$

$$su_v = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/ld = 1.00$$

$$su_v = 0.4 * esuv \text{ nominal } ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } esuv \text{ nominal} = 0.08,$$

considering characteristic value $fsy_v = fs_v/1.2$, from table 5.1, TB DY
For calculation of $esuv \text{ nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
characteristic value $fsy_v = fs_v/1.2$, from table 5.1, TB DY.

$$y_1, sh_1, ft_1, fy_1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs_v = (fs_{jacket} * Asl, \text{mid, jacket} + fs_{mid} * Asl, \text{mid, core}) / Asl, \text{mid} = 781.25$$

$$\text{with } Es_v = (Es_{jacket} * Asl, \text{mid, jacket} + Es_{mid} * Asl, \text{mid, core}) / Asl, \text{mid} = 200000.00$$

$$1 = Asl, \text{ten} / (b * d) * (fs_1 / f_c) = 0.06860752$$

$$2 = Asl, \text{com} / (b * d) * (fs_2 / f_c) = 0.12378842$$

$$v = Asl, \text{mid} / (b * d) * (fs_v / f_c) = 0.04175429$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc \text{ (5A.2, TB DY)} = 30.00$$

$cc(5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.08477074$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.15295169$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.05159117$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->

$su(4.9) = 0.09460844$
 $Mu = MRc(4.14) = 4.6479E+008$
 $u = su(4.1) = 5.6369735E-005$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of $Mu1$ -

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

$u = 6.0907698E-005$
 $Mu = 7.8817E+008$

with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.000307$
 $N = 2309.833$
 $f_c = 30.00$
 $co(5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0053097$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.0053097$
 $w_e(5.4c) = 0.00204688$
 $ase((5.4d), TBDY) = (ase1*A_{ext} + ase2*A_{int})/A_{sec} = 0.14776895$
 $ase1 = 0.14776895$
 $bo_1 = 340.00$
 $ho_1 = 610.00$
 $bi2_1 = 975400.00$
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi2_2 = 557856.00$
 $psh_{min}*F_{ywe} = \text{Min}(psh_x*F_{ywe}, psh_y*F_{ywe}) = 1.38519$
 Expression ((5.4d), TBDY) for $psh_{min}*F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh_x*F_{ywe} = psh1*F_{ywe1} + ps2*F_{ywe2} = 2.45559$
 $ps1(\text{external}) = (A_{sh1}*h1/s1)/A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir_1}*ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 670.00$
 $ps2(\text{internal}) = (A_{sh2}*h2/s2)/A_{sec} = 0.00062519$
 $A_{sh2} = A_{stir_2}*ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 500.00$

$psh_y*F_{ywe} = psh1*F_{ywe1} + ps2*F_{ywe2} = 1.38519$
 $ps1(\text{external}) = (A_{sh1}*h1/s1)/A_{sec} = 0.00156298$
 $A_{sh1} = A_{stir_1}*ns_1 = 157.0796$

No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00025008$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

 $Asec = 268000.00$
 $s1 = 150.00$
 $s2 = 300.00$
 $fyw1 = 781.25$
 $fyw2 = 656.25$
 $fce = 30.00$

From ((5.A5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$

$y1 = 0.0025$
 $sh1 = 0.008$
 $ft1 = 882.7854$
 $fy1 = 735.6545$
 $su1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lo_{u,min} = lb/ld = 1.00$

$su1 = 0.4 \cdot esu1_{nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esu1_{nominal} = 0.08$,

For calculation of $esu1_{nominal}$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.

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

with $fs1 = (fs_{jacket} \cdot Asl_{ten,jacket} + fs_{core} \cdot Asl_{ten,core}) / Asl_{ten} = 735.6545$

with $Es1 = (Es_{jacket} \cdot Asl_{ten,jacket} + Es_{core} \cdot Asl_{ten,core}) / Asl_{ten} = 200000.00$

$y2 = 0.0025$
 $sh2 = 0.008$
 $ft2 = 872.4558$
 $fy2 = 727.0465$
 $su2 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lo_{u,min} = lb/lb_{min} = 1.00$

$su2 = 0.4 \cdot esu2_{nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esu2_{nominal} = 0.08$,

For calculation of $esu2_{nominal}$ and $y2, sh2, ft2, fy2$, it is considered
 characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.

$y2, sh2, ft2, fy2$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs2 = (fs_{jacket} \cdot Asl_{com,jacket} + fs_{core} \cdot Asl_{com,core}) / Asl_{com} = 727.0465$

with $Es2 = (Es_{jacket} \cdot Asl_{com,jacket} + Es_{core} \cdot Asl_{com,core}) / Asl_{com} = 200000.00$

$yv = 0.0025$
 $shv = 0.008$
 $ftv = 937.50$
 $fyv = 781.25$
 $suv = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lo_{u,min} = lb/ld = 1.00$

$suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,

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

For calculation of $esuv_{nominal}$ and yv, shv, ftv, fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.

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

with $fsv = (fs_{jacket} \cdot Asl_{mid,jacket} + fs_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 781.25$

with $Esv = (Es_{jacket} \cdot Asl_{mid,jacket} + Es_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 200000.00$

$1 = Asl_{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.12378842$

$2 = Asl_{com} / (b \cdot d) \cdot (fs2 / fc) = 0.06860752$

$v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.04175429$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc(5A.2, TBDY) = 30.00$$

$$cc(5A.5, TBDY) = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.15295169$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.08477074$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.05159117$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is not satisfied

--->

$v < v_{s,c}$ - RHS eq.(4.5) is satisfied

--->

$$s_u(4.8) = 0.16206515$$

$$M_u = M_{Rc}(4.15) = 7.8817E+008$$

$$u = s_u(4.1) = 6.0907698E-005$$

Calculation of ratio l_b/d

Adequate Lap Length: $l_b/d \geq 1$

Calculation of M_{u2+}

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

$$u = 5.6369735E-005$$

$$M_u = 4.6479E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.000307$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$cc(5A.5, TBDY) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, cc) = 0.0053097$$

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

From (5.4b), TBDY: $\phi_u = 0.0053097$

$$\phi_{we}(5.4c) = 0.00204688$$

$$a_{se}((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$\phi_{sh,min} * F_{ywe} = \text{Min}(\phi_{sh,x} * F_{ywe}, \phi_{sh,y} * F_{ywe}) = 1.38519$$

Expression ((5.4d), TBDY) for $\phi_{sh,min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\phi_{sh,x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.45559$$

$$\phi_{s1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$\phi_{s2}(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

Ash2 = Astir_2*ns_2 = 100.531
 No stirups, ns_2 = 2.00
 h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.38519
 ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
 Ash1 = Astir_1*ns_1 = 157.0796
 No stirups, ns_1 = 2.00
 h1 = 400.00
 ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
 Ash2 = Astir_2*ns_2 = 100.531
 No stirups, ns_2 = 2.00
 h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 781.25

fywe2 = 656.25

fce = 30.00

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

c = confinement factor = 1.00

y1 = 0.0025

sh1 = 0.008

ft1 = 872.4558

fy1 = 727.0465

su1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

lo/lou,min = lb/lb = 1.00

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

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

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

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

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 727.0465

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

y2 = 0.0025

sh2 = 0.008

ft2 = 882.7854

fy2 = 735.6545

su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

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

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

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

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

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 735.6545

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

yv = 0.0025

shv = 0.008

ftv = 937.50

fyv = 781.25

suv = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

lo/lou,min = lb/lb = 1.00

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

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

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
 For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered

```

characteristic value  $f_{sv} = f_{sv}/1.2$ , from table 5.1, TBDY.
 $y_1, sh_1, ft_1, fy_1$ , are also multiplied by  $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$ , from 10.3.5, ASCE 41-17.
with  $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 781.25$ 
with  $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$ 
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.06860752$ 
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.12378842$ 
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.04175429$ 
and confined core properties:
 $b = 340.00$ 
 $d = 597.00$ 
 $d' = 13.00$ 
 $f_{cc} \text{ (5A.2, TBDY)} = 30.00$ 
 $cc \text{ (5A.5, TBDY)} = 0.002$ 
 $c = \text{confinement factor} = 1.00$ 
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.08477074$ 
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.15295169$ 
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.05159117$ 
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
 $v < v_{s,y2}$  - LHS eq.(4.5) is satisfied
--->
 $\mu_u \text{ (4.9)} = 0.09460844$ 
 $\mu_u = M_{Rc} \text{ (4.14)} = 4.6479E+008$ 
 $u = \mu_u \text{ (4.1)} = 5.6369735E-005$ 
-----

Calculation of ratio  $l_b/l_d$ 
-----
Adequate Lap Length:  $l_b/l_d \geq 1$ 
-----

Calculation of  $\mu_{u2}$ -
-----

-----

Calculation of ultimate curvature  $\mu_u$  according to 4.1, Biskinis/Fardis 2013:
 $u = 6.0907698E-005$ 
 $\mu_u = 7.8817E+008$ 
-----

with full section properties:
 $b = 400.00$ 
 $d = 627.00$ 
 $d' = 43.00$ 
 $v = 0.000307$ 
 $N = 2309.833$ 
 $f_c = 30.00$ 
 $cc \text{ (5A.5, TBDY)} = 0.002$ 
Final value of  $\mu_u$ :  $\mu_u^* = \text{shear\_factor} \cdot \text{Max}(\mu_u, cc) = 0.0053097$ 
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY:  $\mu_u = 0.0053097$ 
we (5.4c) = 0.00204688
 $ase \text{ ((5.4d), TBDY)} = (ase_1 \cdot A_{ext} + ase_2 \cdot A_{int}) / A_{sec} = 0.14776895$ 
 $ase_1 = 0.14776895$ 
 $bo_1 = 340.00$ 
 $ho_1 = 610.00$ 
 $bi_2_1 = 975400.00$ 
 $ase_2 = \text{Max}(ase_1, ase_2) = 0.14776895$ 
 $bo_2 = 192.00$ 
 $ho_2 = 492.00$ 
 $bi_2_2 = 557856.00$ 
 $p_{sh,min} \cdot F_{ywe} = \text{Min}(p_{sh,x} \cdot F_{ywe}, p_{sh,y} \cdot F_{ywe}) = 1.38519$ 
Expression ((5.4d), TBDY) for  $p_{sh,min} \cdot F_{ywe}$  has been multiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)
-----
 $p_{sh,x} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{sh2} \cdot F_{ywe2} = 2.45559$ 

```

$$ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00261799$$

$$Ash1 = Astir_1 \cdot ns_1 = 157.0796$$

$$\text{No stirups, } ns_1 = 2.00$$

$$h1 = 670.00$$

$$ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00062519$$

$$Ash2 = Astir_2 \cdot ns_2 = 100.531$$

$$\text{No stirups, } ns_2 = 2.00$$

$$h2 = 500.00$$

$$psh_y \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 1.38519$$

$$ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00156298$$

$$Ash1 = Astir_1 \cdot ns_1 = 157.0796$$

$$\text{No stirups, } ns_1 = 2.00$$

$$h1 = 400.00$$

$$ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00025008$$

$$Ash2 = Astir_2 \cdot ns_2 = 100.531$$

$$\text{No stirups, } ns_2 = 2.00$$

$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 781.25$$

$$fywe2 = 656.25$$

$$fce = 30.00$$

$$\text{From } ((5A5), \text{ TBDY}), \text{ TBDY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 882.7854$$

$$fy1 = 735.6545$$

$$su1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/l_d = 1.00$$

$$su1 = 0.4 \cdot esu1_{\text{nominal}} ((5.5), \text{ TBDY}) = 0.032$$

$$\text{From table 5A.1, TBDY: } esu1_{\text{nominal}} = 0.08,$$

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

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

$$\text{with } fs1 = (fs_{\text{jacket}} \cdot Asl, \text{ten, jacket} + fs_{\text{core}} \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 735.6545$$

$$\text{with } Es1 = (Es_{\text{jacket}} \cdot Asl, \text{ten, jacket} + Es_{\text{core}} \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$$

$$y2 = 0.0025$$

$$sh2 = 0.008$$

$$ft2 = 872.4558$$

$$fy2 = 727.0465$$

$$su2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/l_b, \min = 1.00$$

$$su2 = 0.4 \cdot esu2_{\text{nominal}} ((5.5), \text{ TBDY}) = 0.032$$

$$\text{From table 5A.1, TBDY: } esu2_{\text{nominal}} = 0.08,$$

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

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

$$\text{with } fs2 = (fs_{\text{jacket}} \cdot Asl, \text{com, jacket} + fs_{\text{core}} \cdot Asl, \text{com, core}) / Asl, \text{com} = 727.0465$$

$$\text{with } Es2 = (Es_{\text{jacket}} \cdot Asl, \text{com, jacket} + Es_{\text{core}} \cdot Asl, \text{com, core}) / Asl, \text{com} = 200000.00$$

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 937.50$$

$$fyv = 781.25$$

$$suv = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$l_o/l_o, \min = l_b/d = 1.00$
 $s_u = 0.4 * e_{suv_nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $e_{suv_nominal} = 0.08$,
 considering characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY
 For calculation of $e_{suv_nominal}$ and y_v , sh_v, ft_v, f_y_v , it is considered
 characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY.
 y_1 , sh_1, ft_1, f_y_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b/d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{sv} = (f_{s,jacket} * A_{s,mid,jacket} + f_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 781.25$
 with $E_{sv} = (E_{s,jacket} * A_{s,mid,jacket} + E_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 200000.00$
 $1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.12378842$
 $2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.06860752$
 $v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.04175429$

and confined core properties:

$b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 30.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.15295169$
 $2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.08477074$
 $v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.05159117$

Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is not satisfied
 --->
 $v < v_{s,c}$ - RHS eq.(4.5) is satisfied
 --->
 $su (4.8) = 0.16206515$
 $M_u = M_{Rc} (4.15) = 7.8817E+008$
 $u = su (4.1) = 6.0907698E-005$

Calculation of ratio l_b/d

Adequate Lap Length: $l_b/d \geq 1$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 578810.994$

Calculation of Shear Strength at edge 1, $V_{r1} = 578810.994$
 $V_{r1} = V_n ((22.5.1.1), \text{ACI } 318-14)$

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f * V_f$ '
 where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 192813.976$
 $= 1$ (normal-weight concrete)
 Mean concrete strength: $f_c' = (f_c'_{jacket} * \text{Area}_{jacket} + f_c'_{core} * \text{Area}_{core}) / \text{Area}_{section} = 27.76119$, but $f_c'^{0.5} < =$
 8.3 MPa (22.5.3.1, ACI 318-14)
 $p_w = A_s / (b_w * d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 400.00$
 $d = 536.00$
 $V_u * d / M_u < 1 = 1.00$
 $M_u = 1.1510E+006$
 $V_u = 9840.634$
 From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 385997.017$
 $V_{s1} = 350811.18$ is calculated for jacket, with:
 $d = 536.00$
 $A_v = 157079.633$
 $f_y = 625.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17, 10.3.4)

Vs2 = 35185.838 is calculated for jacket, with:

d2 = 400.00

Av = 100530.965

fy = 525.00

s = 300.00

Vs2 has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.50$

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

From (11-11), ACI 440: $V_s + V_f \leq 750430.726$

Calculation of Shear Strength at edge 2, Vr2 = 578810.994

Vr2 = Vn ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f*Vf'

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

From Table (22.5.5.1), ACI 318-14: Vc = 192813.976

= 1 (normal-weight concrete)

Mean concrete strength: $fc' = (fc'_{jacket} \cdot Area_{jacket} + fc'_{core} \cdot Area_{core}) / Area_{section} = 27.76119$, but $fc'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

pw = As/(bw*d) = 0.00331157

As (tension reinf.) = 709.9999

bw = 400.00

d = 536.00

$V_u \cdot d / \mu_u < 1 = 1.00$

$\mu_u = 1.1510E+006$

Vu = 9840.632

From (11.5.4.8), ACI 318-14: Vs1 + Vs2 = 385997.017

Vs1 = 350811.18 is calculated for jacket, with:

d = 536.00

Av = 157079.633

fy = 625.00

s = 150.00

Vs1 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

Vs2 = 35185.838 is calculated for jacket, with:

d = 400.00

Av = 100530.965

fy = 525.00

s = 300.00

Vs2 has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.50$

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

From (11-11), ACI 440: $V_s + V_f \leq 750430.726$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 2

(Bending local axis: 3)

Section Type: rcjars

Constant Properties

Knowledge Factor, = 0.87

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $fc = f_{cm} = 30.00$

New material of Secondary Member: Steel Strength, $fs = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $fc = f_{cm} = 24.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$
Concrete Elasticity, $E_c = 23025.204$
Steel Elasticity, $E_s = 200000.00$

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, $f_s = 1.25 \cdot f_{sm} = 781.25$
Existing Column
Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 656.25$

External Height, $H = 670.00$
External Width, $W = 400.00$
Internal Height, $H = 500.00$
Internal Width, $W = 200.00$
Cover Thickness, $c = 25.00$
Mean Confinement Factor overall section = 1.00
Element Length, $L = 3000.00$
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length ($l_o/l_{ou,min} \geq 1$)
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, $V_a = -9.0372119E-015$
EDGE -B-
Shear Force, $V_b = 9.0372119E-015$
BOTH EDGES
Axial Force, $F = -2309.833$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $As_t = 709.9999$
-Compression: $As_c = 1668.186$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $As_{t,ten} = 911.0619$
-Compression: $As_{c,com} = 911.0619$
-Middle: $As_{mid} = 556.0619$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.55914272$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 218168.257$
with
 $M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 3.2725E+008$
 $M_{u1+} = 3.2725E+008$, 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
 $M_{u1-} = 3.2725E+008$, 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
 $M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 3.2725E+008$
 $M_{u2+} = 3.2725E+008$, 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
 $M_{u2-} = 3.2725E+008$, 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
and
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$
with
 $V_1 = -9.0372119E-015$, is the shear force acting at edge 1 for the the static loading combination
 $V_2 = 9.0372119E-015$, is the shear force acting at edge 2 for the the static loading combination

Calculation of Mu1+

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

$$\mu = 0.00010507$$

$$Mu = 3.2725E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.0003219$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$cc(5A.5, TBDY) = 0.002$$

$$\text{Final value of } \mu: \mu^* = \text{shear_factor} * \text{Max}(\mu_c, \mu_{cc}) = 0.0053097$$

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

$$\text{From (5.4b), TBDY: } \mu_c = 0.0053097$$

$$\mu_{cc}(5.4c) = 0.00204688$$

$$ase((5.4d), TBDY) = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$$

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

$$ho_1 = 610.00$$

$$bi2_1 = 975400.00$$

$$ase2 = \text{Max}(ase1, ase2) = 0.14776895$$

$$bo_2 = 192.00$$

$$ho_2 = 492.00$$

$$bi2_2 = 557856.00$$

$$psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.38519$$

Expression ((5.4d), TBDY) for $psh_{min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.45559$$

$$ps1(\text{external}) = (Ash1 * h1 / s1) / A_{sec} = 0.00261799$$

$$Ash1 = Astir_1 * ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h1 = 670.00$$

$$ps2(\text{internal}) = (Ash2 * h2 / s2) / A_{sec} = 0.00062519$$

$$Ash2 = Astir_2 * ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h2 = 500.00$$

$$psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.38519$$

$$ps1(\text{external}) = (Ash1 * h1 / s1) / A_{sec} = 0.00156298$$

$$Ash1 = Astir_1 * ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h1 = 400.00$$

$$ps2(\text{internal}) = (Ash2 * h2 / s2) / A_{sec} = 0.00025008$$

$$Ash2 = Astir_2 * ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 781.25$$

$$fywe2 = 656.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TBDY), TBDY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 886.8103$$

$$fy1 = 739.0086$$

$$su1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 1.00$
 $su_1 = 0.4 * esu_{1,nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{1,nominal} = 0.08$,
 For calculation of $esu_{1,nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered
 characteristic value $fsy_1 = fs_1/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_1 = (fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 739.0086$
 with $Es_1 = (Es_{jacket} * A_{sl,ten,jacket} + Es_{core} * A_{sl,ten,core}) / A_{sl,ten} = 200000.00$
 $y_2 = 0.0025$
 $sh_2 = 0.008$
 $ft_2 = 886.8103$
 $fy_2 = 739.0086$
 $su_2 = 0.032$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 1.00$
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,
 For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_2, sh_2, ft_2, fy_2 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 739.0086$
 with $Es_2 = (Es_{jacket} * A_{sl,com,jacket} + Es_{core} * A_{sl,com,core}) / A_{sl,com} = 200000.00$
 $y_v = 0.0025$
 $sh_v = 0.008$
 $ft_v = 895.9746$
 $fy_v = 746.6455$
 $suv = 0.032$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 1.00$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs_{jacket} * A_{sl,mid,jacket} + fs_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 746.6455$
 with $Es_v = (Es_{jacket} * A_{sl,mid,jacket} + Es_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$
 $1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.09382814$
 $2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.09382814$
 $v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.05785932$
 and confined core properties:
 $b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 30.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.11251192$
 $2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.11251192$
 $v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.06938071$
 Case/Assumption: Unconfined full section - Steel rupture
 ' does not satisfy Eq. (4.3)
 --->
 $v < v_{s,c}$ - RHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.1468828$
 $Mu = MRc (4.14) = 3.2725E+008$
 $u = su (4.1) = 0.00010507$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of μ_1 -

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

$$\mu = 0.00010507$$

$$\mu_u = 3.2725E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.0003219$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$cc \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } \mu_u: \mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, cc) = 0.0053097$$

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

$$\text{From (5.4b), TBDY: } \mu_u = 0.0053097$$

$$\mu_{ue} \text{ (5.4c)} = 0.00204688$$

$$ase \text{ ((5.4d), TBDY)} = (ase_1 * A_{ext} + ase_2 * A_{int}) / A_{sec} = 0.14776895$$

$$ase_1 = 0.14776895$$

$$bo_1 = 340.00$$

$$ho_1 = 610.00$$

$$bi_2_1 = 975400.00$$

$$ase_2 = \text{Max}(ase_1, ase_2) = 0.14776895$$

$$bo_2 = 192.00$$

$$ho_2 = 492.00$$

$$bi_2_2 = 557856.00$$

$$psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.38519$$

Expression ((5.4d), TBDY) for $psh_{min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$psh_x * F_{ywe} = psh_1 * F_{ywe1} + ps_2 * F_{ywe2} = 2.45559$$

$$ps_1 \text{ (external)} = (Ash_1 * h_1 / s_1) / A_{sec} = 0.00261799$$

$$Ash_1 = Astir_1 * ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h_1 = 670.00$$

$$ps_2 \text{ (internal)} = (Ash_2 * h_2 / s_2) / A_{sec} = 0.00062519$$

$$Ash_2 = Astir_2 * ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h_2 = 500.00$$

$$psh_y * F_{ywe} = psh_1 * F_{ywe1} + ps_2 * F_{ywe2} = 1.38519$$

$$ps_1 \text{ (external)} = (Ash_1 * h_1 / s_1) / A_{sec} = 0.00156298$$

$$Ash_1 = Astir_1 * ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h_1 = 400.00$$

$$ps_2 \text{ (internal)} = (Ash_2 * h_2 / s_2) / A_{sec} = 0.00025008$$

$$Ash_2 = Astir_2 * ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$fy_{we1} = 781.25$$

$$fy_{we2} = 656.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TBDY), TBDY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

```

y1 = 0.0025
sh1 = 0.008
ft1 = 886.8103
fy1 = 739.0086
su1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 739.0086
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 886.8103
fy2 = 739.0086
su2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 739.0086
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 895.9746
fyv = 746.6455
suv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 746.6455
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09382814
2 = Asl,com/(b*d)*(fs2/fc) = 0.09382814
v = Asl,mid/(b*d)*(fsv/fc) = 0.05785932
and confined core properties:
b = 610.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11251192
2 = Asl,com/(b*d)*(fs2/fc) = 0.11251192
v = Asl,mid/(b*d)*(fsv/fc) = 0.06938071
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)
---->
v < vs,c - RHS eq.(4.5) is satisfied
---->

```

$\mu_u(4.9) = 0.1468828$
 $\mu_u = M_{Rc}(4.14) = 3.2725E+008$
 $u = \mu_u(4.1) = 0.00010507$

Calculation of ratio I_b/I_d

Adequate Lap Length: $I_b/I_d \geq 1$

Calculation of μ_{u2+}

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

$u = 0.00010507$
 $\mu_u = 3.2725E+008$

with full section properties:

$b = 670.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.0003219$
 $N = 2309.833$
 $f_c = 30.00$
 $\alpha(5A.5, TBDY) = 0.002$
 Final value of μ_u : $\mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, \mu_c) = 0.0053097$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $\mu_u = 0.0053097$
 $\mu_{ue}(5.4c) = 0.00204688$
 $\alpha_{se}((5.4d), TBDY) = (\alpha_{se1} * A_{ext} + \alpha_{se2} * A_{int}) / A_{sec} = 0.14776895$
 $\alpha_{se1} = 0.14776895$
 $b_{o_1} = 340.00$
 $h_{o_1} = 610.00$
 $b_{i2_1} = 975400.00$
 $\alpha_{se2} = \text{Max}(\alpha_{se1}, \alpha_{se2}) = 0.14776895$
 $b_{o_2} = 192.00$
 $h_{o_2} = 492.00$
 $b_{i2_2} = 557856.00$

$\mu_{psh,min} * F_{ywe} = \text{Min}(\mu_{psh,x} * F_{ywe}, \mu_{psh,y} * F_{ywe}) = 1.38519$

Expression ((5.4d), TBDY) for $\mu_{psh,min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$\mu_{psh,x} * F_{ywe} = \mu_{psh1} * F_{ywe1} + \mu_{psh2} * F_{ywe2} = 2.45559$
 $\mu_{psh1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h_1 = 670.00$
 $\mu_{psh2}(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirrups, $n_{s_2} = 2.00$
 $h_2 = 500.00$

$\mu_{psh,y} * F_{ywe} = \mu_{psh1} * F_{ywe1} + \mu_{psh2} * F_{ywe2} = 1.38519$
 $\mu_{psh1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h_1 = 400.00$
 $\mu_{psh2}(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirrups, $n_{s_2} = 2.00$
 $h_2 = 200.00$

$A_{sec} = 268000.00$
 $s_1 = 150.00$
 $s_2 = 300.00$

$fy_{we1} = 781.25$
 $fy_{we2} = 656.25$
 $f_{ce} = 30.00$
 From ((5.A.5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$
 $y_1 = 0.0025$
 $sh_1 = 0.008$
 $ft_1 = 886.8103$
 $fy_1 = 739.0086$
 $su_1 = 0.032$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou, min = lb/ld = 1.00$
 $su_1 = 0.4 * esu_1_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_1_nominal = 0.08$,
 For calculation of $esu_1_nominal$ and y_1, sh_1, ft_1, fy_1 , it is considered
 characteristic value $fsy_1 = fs_1/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_1 = (fs_{jacket} * Asl_{ten, jacket} + fs_{core} * Asl_{ten, core}) / Asl_{ten} = 739.0086$
 with $Es_1 = (Es_{jacket} * Asl_{ten, jacket} + Es_{core} * Asl_{ten, core}) / Asl_{ten} = 200000.00$
 $y_2 = 0.0025$
 $sh_2 = 0.008$
 $ft_2 = 886.8103$
 $fy_2 = 739.0086$
 $su_2 = 0.032$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou, min = lb/lb, min = 1.00$
 $su_2 = 0.4 * esu_2_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_2_nominal = 0.08$,
 For calculation of $esu_2_nominal$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = (fs_{jacket} * Asl_{com, jacket} + fs_{core} * Asl_{com, core}) / Asl_{com} = 739.0086$
 with $Es_2 = (Es_{jacket} * Asl_{com, jacket} + Es_{core} * Asl_{com, core}) / Asl_{com} = 200000.00$
 $y_v = 0.0025$
 $sh_v = 0.008$
 $ft_v = 895.9746$
 $fy_v = 746.6455$
 $suv = 0.032$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou, min = lb/ld = 1.00$
 $suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs_{jacket} * Asl_{mid, jacket} + fs_{mid} * Asl_{mid, core}) / Asl_{mid} = 746.6455$
 with $Es_v = (Es_{jacket} * Asl_{mid, jacket} + Es_{mid} * Asl_{mid, core}) / Asl_{mid} = 200000.00$
 $1 = Asl_{ten} / (b * d) * (fs_1 / f_c) = 0.09382814$
 $2 = Asl_{com} / (b * d) * (fs_2 / f_c) = 0.09382814$
 $v = Asl_{mid} / (b * d) * (fsv / f_c) = 0.05785932$
 and confined core properties:
 $b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 30.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl_{ten} / (b * d) * (fs_1 / f_c) = 0.11251192$
 $2 = Asl_{com} / (b * d) * (fs_2 / f_c) = 0.11251192$
 $v = Asl_{mid} / (b * d) * (fsv / f_c) = 0.06938071$

Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)

--->

$v < v_{s,c}$ - RHS eq.(4.5) is satisfied

--->

μ_u (4.9) = 0.1468828

$M_u = M_{Rc}$ (4.14) = 3.2725E+008

$u = \mu_u$ (4.1) = 0.00010507

Calculation of ratio I_b/I_d

Adequate Lap Length: $I_b/I_d \geq 1$

Calculation of μ_u -

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

$u = 0.00010507$

$M_u = 3.2725E+008$

with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.0003219$

$N = 2309.833$

$f_c = 30.00$

ϕ (5A.5, TBDY) = 0.002

Final value of μ_u : $\mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, \phi) = 0.0053097$

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

From (5.4b), TBDY: $\mu_u = 0.0053097$

w_e (5.4c) = 0.00204688

a_{se} ((5.4d), TBDY) = $(a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$

$a_{se1} = 0.14776895$

$b_{o,1} = 340.00$

$h_{o,1} = 610.00$

$b_{i2,1} = 975400.00$

$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$

$b_{o,2} = 192.00$

$h_{o,2} = 492.00$

$b_{i2,2} = 557856.00$

$p_{sh,min} * F_{ywe} = \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.38519$

Expression ((5.4d), TBDY) for $p_{sh,min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh,x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.45559$

p_{s1} (external) = $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$

$A_{sh1} = A_{stir,1} * n_{s,1} = 157.0796$

No stirrups, $n_{s,1} = 2.00$

$h_1 = 670.00$

p_{s2} (internal) = $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$

$A_{sh2} = A_{stir,2} * n_{s,2} = 100.531$

No stirrups, $n_{s,2} = 2.00$

$h_2 = 500.00$

$p_{sh,y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.38519$

p_{s1} (external) = $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$

$A_{sh1} = A_{stir,1} * n_{s,1} = 157.0796$

No stirrups, $n_{s,1} = 2.00$

$h_1 = 400.00$

p_{s2} (internal) = $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$

$A_{sh2} = A_{stir,2} * n_{s,2} = 100.531$

No stirrups, $n_{s,2} = 2.00$

$$h2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

$$\text{From } ((5.5), \text{TBDY}), \text{TBDY: } c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 886.8103$$

$$fy1 = 739.0086$$

$$su1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/ld = 1.00$$

$$su1 = 0.4 * esu1_{nominal} ((5.5), \text{TBDY}) = 0.032$$

From table 5A.1, TBDY: $esu1_{nominal} = 0.08$,

For calculation of $esu1_{nominal}$ and $y1, sh1, ft1, fy1$, it is considered
characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.

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

$$\text{with } fs1 = (fs_{jacket} * Asl, \text{ten}, \text{jacket} + fs_{core} * Asl, \text{ten}, \text{core}) / Asl, \text{ten} = 739.0086$$

$$\text{with } Es1 = (Es_{jacket} * Asl, \text{ten}, \text{jacket} + Es_{core} * Asl, \text{ten}, \text{core}) / Asl, \text{ten} = 200000.00$$

$$y2 = 0.0025$$

$$sh2 = 0.008$$

$$ft2 = 886.8103$$

$$fy2 = 739.0086$$

$$su2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/lb, \min = 1.00$$

$$su2 = 0.4 * esu2_{nominal} ((5.5), \text{TBDY}) = 0.032$$

From table 5A.1, TBDY: $esu2_{nominal} = 0.08$,

For calculation of $esu2_{nominal}$ and $y2, sh2, ft2, fy2$, it is considered
characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.

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

$$\text{with } fs2 = (fs_{jacket} * Asl, \text{com}, \text{jacket} + fs_{core} * Asl, \text{com}, \text{core}) / Asl, \text{com} = 739.0086$$

$$\text{with } Es2 = (Es_{jacket} * Asl, \text{com}, \text{jacket} + Es_{core} * Asl, \text{com}, \text{core}) / Asl, \text{com} = 200000.00$$

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 895.9746$$

$$fyv = 746.6455$$

$$suv = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/ld = 1.00$$

$$suv = 0.4 * esuv_{nominal} ((5.5), \text{TBDY}) = 0.032$$

From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,

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

For calculation of $esuv_{nominal}$ and yv, shv, ftv, fyv , it is considered
characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.

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

$$\text{with } fsv = (fs_{jacket} * Asl, \text{mid}, \text{jacket} + fs_{mid} * Asl, \text{mid}, \text{core}) / Asl, \text{mid} = 746.6455$$

$$\text{with } Esv = (Es_{jacket} * Asl, \text{mid}, \text{jacket} + Es_{mid} * Asl, \text{mid}, \text{core}) / Asl, \text{mid} = 200000.00$$

$$1 = Asl, \text{ten} / (b * d) * (fs1 / f_c) = 0.09382814$$

$$2 = Asl, \text{com} / (b * d) * (fs2 / f_c) = 0.09382814$$

$$v = Asl, \text{mid} / (b * d) * (fsv / f_c) = 0.05785932$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$fcc (5A.2, \text{TBDY}) = 30.00$$

cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = $Asl_{ten}/(b*d)*(fs1/fc) = 0.11251192$
2 = $Asl_{com}/(b*d)*(fs2/fc) = 0.11251192$
v = $Asl_{mid}/(b*d)*(fsv/fc) = 0.06938071$
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)

---->
 $v < v_{s,c}$ - RHS eq.(4.5) is satisfied
---->

su (4.9) = 0.1468828
Mu = MRc (4.14) = 3.2725E+008
u = su (4.1) = 0.00010507

Calculation of ratio lb/l_d

Adequate Lap Length: lb/l_d >= 1

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 390183.487$

Calculation of Shear Strength at edge 1, $V_{r1} = 390183.487$
 $V_{r1} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) 'V_w' is replaced by 'V_w+ f*V_f'
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 180743.977$
= 1 (normal-weight concrete)
Mean concrete strength: $fc' = (fc'_{jacket} * Area_{jacket} + fc'_{core} * Area_{core}) / Area_{section} = 27.76119$, but $fc'^{0.5} < =$
8.3 MPa (22.5.3.1, ACI 318-14)
pw = $As/(bw*d) = 0.00331157$
As (tension reinf.) = 709.9999
bw = 670.00
d = 320.00
 $V_u * d / Mu < 1 = 0.00$
Mu = 6.8565666E-012
Vu = 9.0372119E-015

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 209439.51$
 $V_{s1} = 209439.51$ is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 625.00
s = 150.00
V_{s1} has been multiplied by 1 (s<d/2, according to ASCE 41-17,10.3.4)
V_{s2} = 0.00 is calculated for jacket, with:
d₂ = 160.00
Av = 100530.965
fy = 525.00
s = 300.00
V_{s2} is considered 0 (s>d, according to ASCE 41-17,10.3.4)
V_f ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f < = 750430.726$

Calculation of Shear Strength at edge 2, $V_{r2} = 390183.487$
 $V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) 'V_w' is replaced by 'V_w+ f*V_f'
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 180743.977$
= 1 (normal-weight concrete)
Mean concrete strength: $fc' = (fc'_{jacket} * Area_{jacket} + fc'_{core} * Area_{core}) / Area_{section} = 27.76119$, but $fc'^{0.5} < =$
8.3 MPa (22.5.3.1, ACI 318-14)

$\rho_w = A_s/(b_w \cdot d) = 0.00331157$

A_s (tension reinf.) = 709.9999

$b_w = 670.00$

$d = 320.00$

$V_u \cdot d / M_u < 1 = 0.00$

$M_u = 2.0256286E-011$

$V_u = 9.0372119E-015$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 209439.51$

$V_{s1} = 209439.51$ is calculated for jacket, with:

$d = 320.00$

$A_v = 157079.633$

$f_y = 625.00$

$s = 150.00$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 0.00$ is calculated for jacket, with:

$d = 160.00$

$A_v = 100530.965$

$f_y = 525.00$

$s = 300.00$

V_{s2} is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)

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

From (11-11), ACI 440: $V_s + V_f \leq 750430.726$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 0.87$

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, $f_c = f_{cm} = 30.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_b/l_d > 1$)

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 1.6825104E-011$
 Shear Force, $V2 = 1.3365595E-014$
 Shear Force, $V3 = 4044.385$
 Axial Force, $F = -7187.067$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $As_t = 709.9999$
 -Compression: $As_c = 1668.186$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten} = 911.0619$
 -Compression: $As_{c,com} = 911.0619$
 -Middle: $As_{mid} = 556.0619$
 Longitudinal External Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten,jacket} = 603.1858$
 -Compression: $As_{c,com,jacket} = 603.1858$
 -Middle: $As_{mid,jacket} = 402.1239$
 Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten,core} = 307.8761$
 -Compression: $As_{c,com,core} = 307.8761$
 -Middle: $As_{mid,core} = 153.938$
 Mean Diameter of Tension Reinforcement, $Db_L = 15.20$

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $\phi_R = \phi_u = 0.00791936$
 $\phi_u = \phi_y + \phi_p = 0.00910271$

- Calculation of ϕ_y -

$\phi_y = (M_y * L_s / 3) / E_{eff} = 0.00410271$ ((4.29), Biskinis Phd))
 $M_y = 2.1250E+008$
 $L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 1500.00
 From table 10.5, ASCE 41_17: $E_{eff} = 0.3 * E_c * I_g = 2.5898E+013$

Calculation of Yielding Moment M_y

Calculation of ϕ_y and M_y according to Annex 7 -

$\phi_y = \min(\phi_{y,ten}, \phi_{y,com})$
 $\phi_{y,ten} = 1.0750434E-005$
 with $f_y = 625.00$
 $d = 357.00$
 $\phi_y = 0.22791811$
 $A = 0.00999336$
 $B = 0.00562082$
 with $p_t = 0.00380895$
 $p_c = 0.00380895$
 $p_v = 0.00232477$
 $N = 7187.067$
 $b = 670.00$
 $\phi_y = 0.12044818$
 $\phi_{y,comp} = 2.5846388E-005$
 with $f_c = 27.76119$
 $E_c = 25742.96$
 $\phi_y = 0.22733547$
 $A = 0.00987104$
 $B = 0.00557012$
 with $E_s = 200000.00$

Calculation of ratio I_b/I_d

Adequate Lap Length: $I_b/I_d \geq 1$

- Calculation of ρ -

From table 10-7: $\rho = 0.005$

with:

- Condition i occurred

Beam controlled by flexure: $V_p/V_o \leq 1$

shear control ratio $V_p/V_o = 0.55914272$

- Transverse Reinforcement: NC

- Stirrup Spacing $> d/3$

- Low ductility demand, $\lambda / y < 2$ (table 10-6, ASCE 41-17)
 $= -3.6025504E-022$

- Stirrup Spacing $\leq d/2$

$d = d_{\text{external}} = 357.00$

$s = s_{\text{external}} = 150.00$

- Strength provided by hoops $V_s < 3/4 \cdot \text{design Shear}$

$V_s = 237588.18$, already given in calculation of shear control ratio

design Shear $= 1.3365595E-014$

- $(\rho - \rho') / \rho_{\text{bal}} = -0.33327376$

$= A_{s1} / (b_w \cdot d) = 0.00296835$

Tension Reinf Area: $A_{s1} = 709.9999$

$\rho' = A_{s2} / (b_w \cdot d) = 0.00697431$

Compression Reinf Area: $A_{s2} = 1668.186$

From (B-1), ACI 318-11: $\rho_{\text{bal}} = 0.01202003$

$f_c = (f_{c_{\text{jacket}}} \cdot \text{Area}_{\text{jacket}} + f_{c_{\text{core}}} \cdot \text{Area}_{\text{core}}) / \text{section_area} = 27.76119$

$f_y = f_{y_{\text{jacket_bars}}} = 625.00$

From 10.2.7.3, ACI 318-11: $\lambda = 0.65$

From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000 / (87000 + f_y) = c_b/d_t = 0.003 / (0.003 + y) = 0.48979592$
 $y = 0.003125$

- $V / (b_w \cdot d \cdot f_c^{0.5}) = 1.2771721E-019$, NOTE: units in lb & in
 $b_w = 670.00$

End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (a)

Calculation No. 5

beam B1, Floor 1

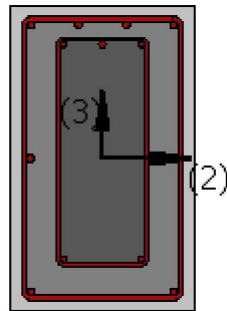
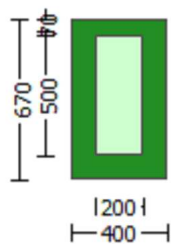
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: End

Local Axis: (2)



Start Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (b)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 0.87$

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, $f_c = f_{c_lower_bound} = 20.00$

New material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 420.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_o/l_{ou,min} = l_b/l_d \geq 1$)

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 1.6825104E-011$

Shear Force, $V_a = 1.3365595E-014$

EDGE -B-

Bending Moment, $M_b = 2.3137405E-011$

Shear Force, $V_b = -1.3365595E-014$

BOTH EDGES

Axial Force, $F = -7187.067$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 709.9999$

-Compression: $As_c = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten} = 911.0619$

-Compression: $As_{l,com} = 911.0619$

-Middle: $A_{sl,mid} = 556.0619$
Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 15.20$

Existing component: From table 7-7, ASCE 41-17: Final Shear Capacity $V_R = V_n = 274161.749$
 $V_n ((22.5.1.1), ACI 318-14) = 315128.448$

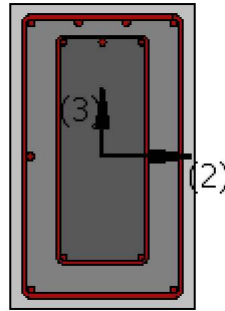
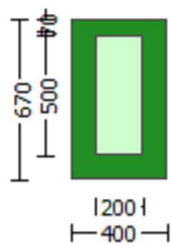
NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f'V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 147576.839$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c,jacket} \cdot Area_{jacket} + f'_{c,core} \cdot Area_{core}) / Area_{section} = 18.50746$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 670.00$
 $d = 320.00$
 $V_u \cdot d / M_u < 1 = 0.00$
 $M_u = 2.3137405E-011$
 $V_u = 1.3365595E-014$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 167551.608$
 $V_{s1} = 167551.608$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 500.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17, 10.3.4)
 $V_{s2} = 0.00$ is calculated for core, with:
 $d = 160.00$
 $A_v = 100530.965$
 $f_y = 420.00$
 $s = 300.00$
 V_{s2} is considered 0 ($s > d$, according to ASCE 41-17, 10.3.4)
 $V_f ((11-3)-(11.4), ACI 440) = 0.00$
From (11-11), ACI 440: $V_s + V_f \leq 612724.122$

End Of Calculation of Shear Capacity for element: beam JB1 of floor 1
At local axis: 2
Integration Section: (b)

Calculation No. 6

beam B1, Floor 1
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)
Analysis: Uniform +X
Check: Chord rotation capacity (ϕ_r)
Edge: End
Local Axis: (2)



Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 0.87$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

#####

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, $f_s = 1.25 \cdot f_{sm} = 781.25$

Existing Column

Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 656.25$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_o/l_{ou, \min} \geq 1$)

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = 9840.634$

EDGE -B-

Shear Force, $V_b = 9840.632$

BOTH EDGES

Axial Force, $F = -2309.833$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $As_t = 709.9999$
 -Compression: $As_c = 1668.186$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten} = 709.9999$
 -Compression: $As_{c,com} = 1266.062$
 -Middle: $As_{mid} = 402.1239$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.92480584$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 535287.788$
 with
 $M_{pr1} = \text{Max}(\mu_{1+}, \mu_{1-}) = 7.8817E+008$
 $\mu_{1+} = 4.6479E+008$, 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
 $\mu_{1-} = 7.8817E+008$, 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
 $M_{pr2} = \text{Max}(\mu_{2+}, \mu_{2-}) = 7.8817E+008$
 $\mu_{2+} = 4.6479E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the static loading combination
 $\mu_{2-} = 7.8817E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination
 and
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$
 with
 $V_1 = 9840.634$, is the shear force acting at edge 1 for the static loading combination
 $V_2 = 9840.632$, is the shear force acting at edge 2 for the static loading combination

Calculation of μ_{1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 5.6369735E-005$
 $M_u = 4.6479E+008$

with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.000307$
 $N = 2309.833$
 $f_c = 30.00$
 $\phi_c \text{ (5A.5, TBDY)} = 0.002$
 Final value of ϕ_u : $\phi_u^* = \text{shear_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.0053097$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $\phi_u = 0.0053097$
 $w_e \text{ (5.4c)} = 0.00204688$
 $\phi_{se} \text{ ((5.4d), TBDY)} = (\phi_{se1} \cdot A_{ext} + \phi_{se2} \cdot A_{int})/A_{sec} = 0.14776895$
 $\phi_{se1} = 0.14776895$
 $b_{o_1} = 340.00$
 $h_{o_1} = 610.00$
 $b_{i2_1} = 975400.00$
 $\phi_{se2} = \text{Max}(\phi_{se1}, \phi_{se2}) = 0.14776895$
 $b_{o_2} = 192.00$
 $h_{o_2} = 492.00$
 $b_{i2_2} = 557856.00$
 $\phi_{psh,min} \cdot F_{ywe} = \text{Min}(\phi_{psh,x} \cdot F_{ywe}, \phi_{psh,y} \cdot F_{ywe}) = 1.38519$
 Expression ((5.4d), TBDY) for $\phi_{psh,min} \cdot F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$\phi_{psh,x} \cdot F_{ywe} = \phi_{psh1} \cdot F_{ywe1} + \phi_{psh2} \cdot F_{ywe2} = 2.45559$

$$ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00261799$$

$$Ash1 = Astir_1 \cdot ns_1 = 157.0796$$

$$\text{No stirups, } ns_1 = 2.00$$

$$h1 = 670.00$$

$$ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00062519$$

$$Ash2 = Astir_2 \cdot ns_2 = 100.531$$

$$\text{No stirups, } ns_2 = 2.00$$

$$h2 = 500.00$$

$$psh_y \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 1.38519$$

$$ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00156298$$

$$Ash1 = Astir_1 \cdot ns_1 = 157.0796$$

$$\text{No stirups, } ns_1 = 2.00$$

$$h1 = 400.00$$

$$ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00025008$$

$$Ash2 = Astir_2 \cdot ns_2 = 100.531$$

$$\text{No stirups, } ns_2 = 2.00$$

$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 781.25$$

$$fywe2 = 656.25$$

$$fce = 30.00$$

$$\text{From } ((5A5), \text{ TBDY}), \text{ TBDY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 872.4558$$

$$fy1 = 727.0465$$

$$su1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/ld = 1.00$$

$$su1 = 0.4 \cdot esu1_nominal \text{ ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } esu1_nominal = 0.08,$$

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

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

$$\text{with } fs1 = (fs_jacket \cdot Asl, \text{ten, jacket} + fs_core \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 727.0465$$

$$\text{with } Es1 = (Es_jacket \cdot Asl, \text{ten, jacket} + Es_core \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$$

$$y2 = 0.0025$$

$$sh2 = 0.008$$

$$ft2 = 882.7854$$

$$fy2 = 735.6545$$

$$su2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/lb, \min = 1.00$$

$$su2 = 0.4 \cdot esu2_nominal \text{ ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } esu2_nominal = 0.08,$$

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

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

$$\text{with } fs2 = (fs_jacket \cdot Asl, \text{com, jacket} + fs_core \cdot Asl, \text{com, core}) / Asl, \text{com} = 735.6545$$

$$\text{with } Es2 = (Es_jacket \cdot Asl, \text{com, jacket} + Es_core \cdot Asl, \text{com, core}) / Asl, \text{com} = 200000.00$$

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 937.50$$

$$fyv = 781.25$$

$$suv = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$l_o/l_{ou,min} = l_b/l_d = 1.00$
 $suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv , shv , ftv , fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1$, $sh1$, $ft1$, $fy1$, are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs_jacket * Asl_mid,jacket + fs_mid * Asl_mid,core) / Asl_mid = 781.25$
 with $Esv = (Es_jacket * Asl_mid,jacket + Es_mid * Asl_mid,core) / Asl_mid = 200000.00$
 $1 = Asl_ten / (b * d) * (fs1 / fc) = 0.06860752$
 $2 = Asl_com / (b * d) * (fs2 / fc) = 0.12378842$
 $v = Asl_mid / (b * d) * (fsv / fc) = 0.04175429$
 and confined core properties:
 $b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 30.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl_ten / (b * d) * (fs1 / fc) = 0.08477074$
 $2 = Asl_com / (b * d) * (fs2 / fc) = 0.15295169$
 $v = Asl_mid / (b * d) * (fsv / fc) = 0.05159117$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < vs,y2$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.09460844$
 $Mu = MRc (4.14) = 4.6479E+008$
 $u = su (4.1) = 5.6369735E-005$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of $Mu1$ -

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

$u = 6.0907698E-005$
 $Mu = 7.8817E+008$

with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.000307$
 $N = 2309.833$
 $fc = 30.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0053097$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.0053097$
 $we (5.4c) = 0.00204688$
 $ase ((5.4d), TBDY) = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$
 $ase1 = 0.14776895$
 $bo_1 = 340.00$
 $ho_1 = 610.00$
 $bi2_1 = 975400.00$
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi2_2 = 557856.00$

$psh,min*Fywe = \text{Min}(psh,x*Fywe, psh,y*Fywe) = 1.38519$
 Expression ((5.4d), TBDY) for $psh,min*Fywe$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh_x*Fywe = psh1*Fywe1 + ps2*Fywe2 = 2.45559$
 $ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00261799$
 $Ash1 = Astir_1*ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 670.00$
 $ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00062519$
 $Ash2 = Astir_2*ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 500.00$

$psh_y*Fywe = psh1*Fywe1 + ps2*Fywe2 = 1.38519$
 $ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00156298$
 $Ash1 = Astir_1*ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00025008$
 $Ash2 = Astir_2*ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

$Asec = 268000.00$
 $s1 = 150.00$
 $s2 = 300.00$
 $fywe1 = 781.25$
 $fywe2 = 656.25$
 $fce = 30.00$

From ((5.A5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$

$y1 = 0.0025$
 $sh1 = 0.008$
 $ft1 = 882.7854$
 $fy1 = 735.6545$
 $su1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/ld = 1.00$

$su1 = 0.4*esu1_nominal \text{ ((5.5), TBDY)} = 0.032$

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

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

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

with $fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 735.6545$

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

$y2 = 0.0025$
 $sh2 = 0.008$
 $ft2 = 872.4558$
 $fy2 = 727.0465$
 $su2 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lou,min = lb/lb,min = 1.00$

$su2 = 0.4*esu2_nominal \text{ ((5.5), TBDY)} = 0.032$

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

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

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

with $fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 727.0465$

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

$yv = 0.0025$
 $shv = 0.008$
 $ftv = 937.50$

```

fyv = 781.25
suv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lo,min = lb/ld = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fsjacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 781.25
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.12378842
2 = Asl,com/(b*d)*(fs2/fc) = 0.06860752
v = Asl,mid/(b*d)*(fsv/fc) = 0.04175429
and confined core properties:
b = 340.00
d = 597.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.15295169
2 = Asl,com/(b*d)*(fs2/fc) = 0.08477074
v = Asl,mid/(b*d)*(fsv/fc) = 0.05159117
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.8) = 0.16206515
Mu = MRc (4.15) = 7.8817E+008
u = su (4.1) = 6.0907698E-005

```

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

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

```

u = 5.6369735E-005
Mu = 4.6479E+008

```

with full section properties:

```

b = 400.00
d = 627.00
d' = 43.00
v = 0.000307
N = 2309.833
fc = 30.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.0053097
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0053097
we (5.4c) = 0.00204688
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.14776895
ase1 = 0.14776895

```

$bo_1 = 340.00$
 $ho_1 = 610.00$
 $bi2_1 = 975400.00$
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi2_2 = 557856.00$
 $psh, min*Fywe = \text{Min}(psh, x*Fywe, psh, y*Fywe) = 1.38519$
 Expression ((5.4d), TBDY) for $psh, min*Fywe$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh_x*Fywe = psh1*Fywe1 + ps2*Fywe2 = 2.45559$
 $ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00261799$
 $Ash1 = Astir_1*ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 670.00$
 $ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00062519$
 $Ash2 = Astir_2*ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 500.00$

$psh_y*Fywe = psh1*Fywe1 + ps2*Fywe2 = 1.38519$
 $ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00156298$
 $Ash1 = Astir_1*ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00025008$
 $Ash2 = Astir_2*ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

$Asec = 268000.00$
 $s1 = 150.00$
 $s2 = 300.00$
 $fywe1 = 781.25$
 $fywe2 = 656.25$
 $fce = 30.00$

From ((5.A5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$

$y1 = 0.0025$
 $sh1 = 0.008$
 $ft1 = 872.4558$
 $fy1 = 727.0465$
 $su1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lo, min = lb/ld = 1.00$

$su1 = 0.4*esu1_nominal \text{ ((5.5), TBDY)} = 0.032$

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

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

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

with $fs1 = (fs, jacket*Asl, ten, jacket + fs, core*Asl, ten, core)/Asl, ten = 727.0465$

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

$y2 = 0.0025$
 $sh2 = 0.008$
 $ft2 = 882.7854$
 $fy2 = 735.6545$
 $su2 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lo, min = lb/lb, min = 1.00$

$su2 = 0.4*esu2_nominal \text{ ((5.5), TBDY)} = 0.032$

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

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

characteristic value $f_{sy2} = f_{s2}/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{s2} = (f_{sjacket} \cdot A_{sl,com,jacket} + f_{s,core} \cdot A_{sl,com,core}) / A_{sl,com} = 735.6545$
 with $E_{s2} = (E_{sjacket} \cdot A_{sl,com,jacket} + E_{s,core} \cdot A_{sl,com,core}) / A_{sl,com} = 200000.00$
 $y_v = 0.0025$
 $sh_v = 0.008$
 $ft_v = 937.50$
 $fy_v = 781.25$
 $suv = 0.032$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 1.00$
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{sv} = (f_{sjacket} \cdot A_{sl,mid,jacket} + f_{s,mid} \cdot A_{sl,mid,core}) / A_{sl,mid} = 781.25$
 with $E_{sv} = (E_{sjacket} \cdot A_{sl,mid,jacket} + E_{s,mid} \cdot A_{sl,mid,core}) / A_{sl,mid} = 200000.00$
 $1 = A_{sl,ten} / (b \cdot d) \cdot (f_{s1}/f_c) = 0.06860752$
 $2 = A_{sl,com} / (b \cdot d) \cdot (f_{s2}/f_c) = 0.12378842$
 $v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv}/f_c) = 0.04175429$

and confined core properties:

$b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 30.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten} / (b \cdot d) \cdot (f_{s1}/f_c) = 0.08477074$
 $2 = A_{sl,com} / (b \cdot d) \cdot (f_{s2}/f_c) = 0.15295169$
 $v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv}/f_c) = 0.05159117$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$su (4.9) = 0.09460844$
 $Mu = MR_c (4.14) = 4.6479E+008$
 $u = su (4.1) = 5.6369735E-005$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of Mu_2 -

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

$u = 6.0907698E-005$
 $Mu = 7.8817E+008$

with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.000307$
 $N = 2309.833$
 $f_c = 30.00$
 $cc (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} \cdot \text{Max}(cu, cc) = 0.0053097$

The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $c_u = 0.0053097$
 w_e (5.4c) = 0.00204688
 a_{se} ((5.4d), TBDY) = $(a_{se1} \cdot A_{ext} + a_{se2} \cdot A_{int}) / A_{sec} = 0.14776895$
 $a_{se1} = 0.14776895$
 $b_{o_1} = 340.00$
 $h_{o_1} = 610.00$
 $b_{i2_1} = 975400.00$
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$
 $b_{o_2} = 192.00$
 $h_{o_2} = 492.00$
 $b_{i2_2} = 557856.00$
 $p_{sh, \min} \cdot F_{ywe} = \text{Min}(p_{sh, x} \cdot F_{ywe}, p_{sh, y} \cdot F_{ywe}) = 1.38519$
 Expression ((5.4d), TBDY) for $p_{sh, \min} \cdot F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh, x} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{s2} \cdot F_{ywe2} = 2.45559$
 p_{s1} (external) = $(A_{sh1} \cdot h_1 / s_1) / A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir_1} \cdot n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h_1 = 670.00$
 p_{s2} (internal) = $(A_{sh2} \cdot h_2 / s_2) / A_{sec} = 0.00062519$
 $A_{sh2} = A_{stir_2} \cdot n_{s_2} = 100.531$
 No stirrups, $n_{s_2} = 2.00$
 $h_2 = 500.00$

$p_{sh, y} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{s2} \cdot F_{ywe2} = 1.38519$
 p_{s1} (external) = $(A_{sh1} \cdot h_1 / s_1) / A_{sec} = 0.00156298$
 $A_{sh1} = A_{stir_1} \cdot n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h_1 = 400.00$
 p_{s2} (internal) = $(A_{sh2} \cdot h_2 / s_2) / A_{sec} = 0.00025008$
 $A_{sh2} = A_{stir_2} \cdot n_{s_2} = 100.531$
 No stirrups, $n_{s_2} = 2.00$
 $h_2 = 200.00$

$A_{sec} = 268000.00$
 $s_1 = 150.00$
 $s_2 = 300.00$
 $f_{ywe1} = 781.25$
 $f_{ywe2} = 656.25$
 $f_{ce} = 30.00$

From ((5.A5), TBDY), TBDY: $c_c = 0.002$
 c = confinement factor = 1.00

$y_1 = 0.0025$
 $sh_1 = 0.008$
 $ft_1 = 882.7854$
 $fy_1 = 735.6545$
 $su_1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

$l_o / l_{ou, \min} = l_b / l_d = 1.00$

$su_1 = 0.4 \cdot esu_{1_nominal}$ ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: $esu_{1_nominal} = 0.08$,

For calculation of $esu_{1_nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered
 characteristic value $fsy_1 = fs_1 / 1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b / l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs_1 = (f_{s, \text{jacket}} \cdot A_{s, \text{ten, jacket}} + f_{s, \text{core}} \cdot A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 735.6545$

with $Es_1 = (E_{s, \text{jacket}} \cdot A_{s, \text{ten, jacket}} + E_{s, \text{core}} \cdot A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 200000.00$

$y_2 = 0.0025$
 $sh_2 = 0.008$
 $ft_2 = 872.4558$
 $fy_2 = 727.0465$
 $su_2 = 0.032$

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

Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 1.00$
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,
 For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 727.0465$
 with $Es_2 = (Es_{jacket} * A_{sl,com,jacket} + Es_{core} * A_{sl,com,core}) / A_{sl,com} = 200000.00$
 $y_v = 0.0025$
 $sh_v = 0.008$
 $ft_v = 937.50$
 $fy_v = 781.25$
 $suv = 0.032$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 1.00$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsyv = fs_v/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fsyv = fs_v/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_v = (fs_{jacket} * A_{sl,mid,jacket} + fs_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 781.25$
 with $Es_v = (Es_{jacket} * A_{sl,mid,jacket} + Es_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$
 $1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.12378842$
 $2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.06860752$
 $v = A_{sl,mid} / (b * d) * (fs_v / fc) = 0.04175429$
 and confined core properties:
 $b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 30.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.15295169$
 $2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.08477074$
 $v = A_{sl,mid} / (b * d) * (fs_v / fc) = 0.05159117$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is not satisfied

--->
 $v < v_{s,c}$ - RHS eq.(4.5) is satisfied

--->
 $su (4.8) = 0.16206515$
 $Mu = MRc (4.15) = 7.8817E+008$
 $u = su (4.1) = 6.0907698E-005$

 Calculation of ratio l_b/l_d

 Adequate Lap Length: $l_b/l_d \geq 1$

 Calculation of Shear Strength $V_r = Min(V_{r1}, V_{r2}) = 578810.994$

 Calculation of Shear Strength at edge 1, $V_{r1} = 578810.994$
 $V_{r1} = V_n ((22.5.1.1), ACI 318-14)$

 NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f*Vf'
 where Vf is the contribution of FRPs (11.3), ACI 440).

 From Table (22.5.5.1), ACI 318-14: $V_c = 192813.976$

= 1 (normal-weight concrete)
Mean concrete strength: $fc' = (fc'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + fc'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 27.76119$, but $fc'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 400.00$
 $d = 536.00$
 $V_u \cdot d / M_u < 1 = 1.00$
 $M_u = 1.1510 \text{E}+006$
 $V_u = 9840.634$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 385997.017$
 $V_{s1} = 350811.18$ is calculated for jacket, with:
 $d = 536.00$
 $A_v = 157079.633$
 $f_y = 625.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 35185.838$ is calculated for jacket, with:
 $d = 400.00$
 $A_v = 100530.965$
 $f_y = 525.00$
 $s = 300.00$
 V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
 V_f ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f \leq 750430.726$

Calculation of Shear Strength at edge 2, $V_{r2} = 578810.994$
 $V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ ' where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 192813.976$
= 1 (normal-weight concrete)
Mean concrete strength: $fc' = (fc'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + fc'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 27.76119$, but $fc'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 400.00$
 $d = 536.00$
 $V_u \cdot d / M_u < 1 = 1.00$
 $M_u = 1.1510 \text{E}+006$
 $V_u = 9840.632$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 385997.017$
 $V_{s1} = 350811.18$ is calculated for jacket, with:
 $d = 536.00$
 $A_v = 157079.633$
 $f_y = 625.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 35185.838$ is calculated for jacket, with:
 $d = 400.00$
 $A_v = 100530.965$
 $f_y = 525.00$
 $s = 300.00$
 V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
 V_f ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f \leq 750430.726$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1
At local axis: 3

```

Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjars

Constant Properties
-----
Knowledge Factor,   = 0.87
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 30.00
New material of Secondary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 24.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 525.00
Concrete Elasticity, Ec = 23025.204
Steel Elasticity, Es = 200000.00
#####
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 781.25
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 656.25
#####
External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>= 1)
No FRP Wrapping
-----

Stepwise Properties
-----
At local axis: 2
EDGE -A-
Shear Force, Va = -9.0372119E-015
EDGE -B-
Shear Force, Vb = 9.0372119E-015
BOTH EDGES
Axial Force, F = -2309.833
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 709.9999
-Compression: Aslc = 1668.186
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 911.0619
-Compression: Asl,com = 911.0619
-Middle: Asl,mid = 556.0619
-----
-----

Calculation of Shear Capacity ratio , Ve/Vr = 0.55914272
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln ± wu*ln/2 = 218168.257

```

with
 $M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 3.2725E+008$
 $M_{u1+} = 3.2725E+008$, 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
 $M_{u1-} = 3.2725E+008$, 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
 $M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 3.2725E+008$
 $M_{u2+} = 3.2725E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the static loading combination
 $M_{u2-} = 3.2725E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination
and
 $\pm v_w \cdot l_n = (|V1| + |V2|)/2$
with
 $V1 = -9.0372119E-015$, is the shear force acting at edge 1 for the static loading combination
 $V2 = 9.0372119E-015$, is the shear force acting at edge 2 for the static loading combination

Calculation of M_{u1+}

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

$\phi_u = 0.00010507$
 $M_u = 3.2725E+008$

with full section properties:

$b = 670.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.0003219$
 $N = 2309.833$
 $f_c = 30.00$
 $\alpha (5A.5, \text{TBDY}) = 0.002$
Final value of ϕ_u : $\phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.0053097$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $\phi_u = 0.0053097$
 $\phi_{ue} (5.4c) = 0.00204688$
 $\phi_{se} ((5.4d), \text{TBDY}) = (\phi_{se1} * A_{ext} + \phi_{se2} * A_{int}) / A_{sec} = 0.14776895$
 $\phi_{se1} = 0.14776895$
 $b_{o_1} = 340.00$
 $h_{o_1} = 610.00$
 $b_{i2_1} = 975400.00$
 $\phi_{se2} = \text{Max}(\phi_{se1}, \phi_{se2}) = 0.14776895$
 $b_{o_2} = 192.00$
 $h_{o_2} = 492.00$
 $b_{i2_2} = 557856.00$

$\phi_{sh, \min} * F_{ywe} = \text{Min}(\phi_{sh, x} * F_{ywe}, \phi_{sh, y} * F_{ywe}) = 1.38519$
Expression ((5.4d), TBDY) for $\phi_{sh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

 $\phi_{sh, x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.45559$
 $\phi_{sh1} \text{ (external)} = (A_{sh1} * h1 / s1) / A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
No stirrups, $n_{s_1} = 2.00$
 $h1 = 670.00$
 $\phi_{sh2} \text{ (internal)} = (A_{sh2} * h2 / s2) / A_{sec} = 0.00062519$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
No stirrups, $n_{s_2} = 2.00$
 $h2 = 500.00$

$\phi_{sh, y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.38519$
 $\phi_{sh1} \text{ (external)} = (A_{sh1} * h1 / s1) / A_{sec} = 0.00156298$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
No stirrups, $n_{s_1} = 2.00$
 $h1 = 400.00$
 $\phi_{sh2} \text{ (internal)} = (A_{sh2} * h2 / s2) / A_{sec} = 0.00025008$

Ash2 = Astir_2*ns_2 = 100.531
 No stirups, ns_2 = 2.00
 h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 781.25

fywe2 = 656.25

fce = 30.00

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

c = confinement factor = 1.00

y1 = 0.0025

sh1 = 0.008

ft1 = 886.8103

fy1 = 739.0086

su1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

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

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

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

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

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 739.0086

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

y2 = 0.0025

sh2 = 0.008

ft2 = 886.8103

fy2 = 739.0086

su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

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

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

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

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

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 739.0086

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

yv = 0.0025

shv = 0.008

ftv = 895.9746

fyv = 746.6455

suv = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

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

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

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
 For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered

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

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

with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 746.6455

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

1 = Asl,ten/(b*d)*(fs1/fc) = 0.09382814

2 = Asl,com/(b*d)*(fs2/fc) = 0.09382814

v = Asl,mid/(b*d)*(fsv/fc) = 0.05785932

and confined core properties:

b = 610.00

d = 327.00

```

d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11251192
2 = Asl,com/(b*d)*(fs2/fc) = 0.11251192
v = Asl,mid/(b*d)*(fsv/fc) = 0.06938071
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.9) = 0.1468828
Mu = MRc (4.14) = 3.2725E+008
u = su (4.1) = 0.00010507

```

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

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

```

u = 0.00010507
Mu = 3.2725E+008

```

with full section properties:

```

b = 670.00
d = 357.00
d' = 43.00
v = 0.0003219
N = 2309.833
fc = 30.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.0053097
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0053097
we (5.4c) = 0.00204688
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.14776895
ase1 = 0.14776895
bo_1 = 340.00
ho_1 = 610.00
bi2_1 = 975400.00
ase2 = Max(ase1,ase2) = 0.14776895
bo_2 = 192.00
ho_2 = 492.00
bi2_2 = 557856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.38519

```

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

```

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.45559
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirrups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirrups, ns_2 = 2.00
h2 = 500.00

```

```

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.38519

```

$$ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00156298$$

$$Ash1 = Astir_1 \cdot ns_1 = 157.0796$$

$$\text{No stirups, } ns_1 = 2.00$$

$$h1 = 400.00$$

$$ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00025008$$

$$Ash2 = Astir_2 \cdot ns_2 = 100.531$$

$$\text{No stirups, } ns_2 = 2.00$$

$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 781.25$$

$$fywe2 = 656.25$$

$$fce = 30.00$$

$$\text{From } ((5A5), \text{TB DY}), \text{TB DY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 886.8103$$

$$fy1 = 739.0086$$

$$su1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/ld = 1.00$$

$$su1 = 0.4 \cdot esu1_nominal \text{ ((5.5), TB DY)} = 0.032$$

$$\text{From table 5A.1, TB DY: } esu1_nominal = 0.08,$$

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

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

$$\text{with } fs1 = (fs_jacket \cdot Asl, \text{ten, jacket} + fs_core \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 739.0086$$

$$\text{with } Es1 = (Es_jacket \cdot Asl, \text{ten, jacket} + Es_core \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$$

$$y2 = 0.0025$$

$$sh2 = 0.008$$

$$ft2 = 886.8103$$

$$fy2 = 739.0086$$

$$su2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/lb, \min = 1.00$$

$$su2 = 0.4 \cdot esu2_nominal \text{ ((5.5), TB DY)} = 0.032$$

$$\text{From table 5A.1, TB DY: } esu2_nominal = 0.08,$$

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

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

$$\text{with } fs2 = (fs_jacket \cdot Asl, \text{com, jacket} + fs_core \cdot Asl, \text{com, core}) / Asl, \text{com} = 739.0086$$

$$\text{with } Es2 = (Es_jacket \cdot Asl, \text{com, jacket} + Es_core \cdot Asl, \text{com, core}) / Asl, \text{com} = 200000.00$$

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 895.9746$$

$$fyv = 746.6455$$

$$suv = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/ld = 1.00$$

$$suv = 0.4 \cdot esuv_nominal \text{ ((5.5), TB DY)} = 0.032$$

$$\text{From table 5A.1, TB DY: } esuv_nominal = 0.08,$$

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

For calculation of esuv_nominal and yv, shv, ftv, fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TB DY.

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

$$\text{with } fsv = (fs_jacket \cdot Asl, \text{mid, jacket} + fs_mid \cdot Asl, \text{mid, core}) / Asl, \text{mid} = 746.6455$$

$$\text{with } Esv = (Es_jacket \cdot Asl, \text{mid, jacket} + Es_mid \cdot Asl, \text{mid, core}) / Asl, \text{mid} = 200000.00$$

$$1 = Asl, \text{ten} / (b \cdot d) \cdot (fs1 / fce) = 0.09382814$$

$2 = A_{sl,com}/(b*d)*(f_s2/f_c) = 0.09382814$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.05785932$
 and confined core properties:
 $b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 30.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.11251192$
 $2 = A_{sl,com}/(b*d)*(f_s2/f_c) = 0.11251192$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.06938071$
 Case/Assumption: Unconfined full section - Steel rupture
 ' does not satisfy Eq. (4.3)

--->
 $v < v_{s,c}$ - RHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.1468828$
 $\mu = M_{Rc} (4.14) = 3.2725E+008$
 $u = su (4.1) = 0.00010507$

Calculation of ratio l_b/d

Adequate Lap Length: $l_b/d \geq 1$

Calculation of μ_{2+}

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:
 $u = 0.00010507$
 $\mu = 3.2725E+008$

with full section properties:

$b = 670.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.0003219$
 $N = 2309.833$
 $f_c = 30.00$
 $cc (5A.5, TBDY) = 0.002$
 Final value of μ : $\mu^* = \text{shear_factor} * \text{Max}(\mu_c, cc) = 0.0053097$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $\mu_c = 0.0053097$
 $\mu_{we} (5.4c) = 0.00204688$
 $\mu_{ase} ((5.4d), TBDY) = (\mu_{ase1} * A_{ext} + \mu_{ase2} * A_{int}) / A_{sec} = 0.14776895$
 $\mu_{ase1} = 0.14776895$
 $b_{o_1} = 340.00$
 $h_{o_1} = 610.00$
 $b_{i2_1} = 975400.00$
 $\mu_{ase2} = \text{Max}(\mu_{ase1}, \mu_{ase2}) = 0.14776895$
 $b_{o_2} = 192.00$
 $h_{o_2} = 492.00$
 $b_{i2_2} = 557856.00$
 $\mu_{psh,min} * F_{ywe} = \text{Min}(\mu_{psh,x} * F_{ywe}, \mu_{psh,y} * F_{ywe}) = 1.38519$
 Expression ((5.4d), TBDY) for $\mu_{psh,min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$\mu_{psh,x} * F_{ywe} = \mu_{psh1} * F_{ywe1} + \mu_{psh2} * F_{ywe2} = 2.45559$
 $\mu_{ps1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h_1 = 670.00$
 $\mu_{ps2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$

Ash2 = Astir_2*ns_2 = 100.531
 No stirups, ns_2 = 2.00
 h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.38519
 ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
 Ash1 = Astir_1*ns_1 = 157.0796
 No stirups, ns_1 = 2.00
 h1 = 400.00
 ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
 Ash2 = Astir_2*ns_2 = 100.531
 No stirups, ns_2 = 2.00
 h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 781.25

fywe2 = 656.25

fce = 30.00

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

c = confinement factor = 1.00

y1 = 0.0025

sh1 = 0.008

ft1 = 886.8103

fy1 = 739.0086

su1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

lo/lou,min = lb/ld = 1.00

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

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

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

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

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 739.0086

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

y2 = 0.0025

sh2 = 0.008

ft2 = 886.8103

fy2 = 739.0086

su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

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

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

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

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

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 739.0086

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

yv = 0.0025

shv = 0.008

ftv = 895.9746

fyv = 746.6455

suv = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

lo/lou,min = lb/ld = 1.00

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

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

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

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

characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
with $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 746.6455$
with $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.09382814$
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.09382814$
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.05785932$
and confined core properties:
 $b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $f_{cc} \text{ (5A.2, TBDY)} = 30.00$
 $cc \text{ (5A.5, TBDY)} = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.11251192$
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.11251192$
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.06938071$
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)
--->
 $v < v_{s,c}$ - RHS eq.(4.5) is satisfied
--->
 $su \text{ (4.9)} = 0.1468828$
 $Mu = MR_c \text{ (4.14)} = 3.2725E+008$
 $u = su \text{ (4.1)} = 0.00010507$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of Mu_2 -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 0.00010507$
 $Mu = 3.2725E+008$

with full section properties:
 $b = 670.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.0003219$
 $N = 2309.833$
 $f_c = 30.00$
 $cc \text{ (5A.5, TBDY)} = 0.002$
Final value of cu : $cu^* = \text{shear_factor} \cdot \text{Max}(cu, cc) = 0.0053097$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $cu = 0.0053097$
we (5.4c) = 0.00204688
 $ase \text{ ((5.4d), TBDY)} = (ase1 \cdot A_{ext} + ase2 \cdot A_{int}) / A_{sec} = 0.14776895$
 $ase1 = 0.14776895$
 $bo_1 = 340.00$
 $ho_1 = 610.00$
 $bi2_1 = 975400.00$
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi2_2 = 557856.00$
 $psh_{min} \cdot F_{ywe} = \text{Min}(psh_x \cdot F_{ywe}, psh_y \cdot F_{ywe}) = 1.38519$
Expression ((5.4d), TBDY) for $psh_{min} \cdot F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

 $psh_x \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 2.45559$

$$ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00261799$$

$$Ash1 = Astir_1 \cdot ns_1 = 157.0796$$

$$\text{No stirups, } ns_1 = 2.00$$

$$h1 = 670.00$$

$$ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00062519$$

$$Ash2 = Astir_2 \cdot ns_2 = 100.531$$

$$\text{No stirups, } ns_2 = 2.00$$

$$h2 = 500.00$$

$$psh_y \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 1.38519$$

$$ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00156298$$

$$Ash1 = Astir_1 \cdot ns_1 = 157.0796$$

$$\text{No stirups, } ns_1 = 2.00$$

$$h1 = 400.00$$

$$ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00025008$$

$$Ash2 = Astir_2 \cdot ns_2 = 100.531$$

$$\text{No stirups, } ns_2 = 2.00$$

$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 781.25$$

$$fywe2 = 656.25$$

$$fce = 30.00$$

$$\text{From } ((5A5), \text{ TBDY}), \text{ TBDY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 886.8103$$

$$fy1 = 739.0086$$

$$su1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/l_d = 1.00$$

$$su1 = 0.4 \cdot esu1_{\text{nominal}} ((5.5), \text{ TBDY}) = 0.032$$

$$\text{From table 5A.1, TBDY: } esu1_{\text{nominal}} = 0.08,$$

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

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

$$\text{with } fs1 = (fs_{\text{jacket}} \cdot Asl, \text{ten, jacket} + fs_{\text{core}} \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 739.0086$$

$$\text{with } Es1 = (Es_{\text{jacket}} \cdot Asl, \text{ten, jacket} + Es_{\text{core}} \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$$

$$y2 = 0.0025$$

$$sh2 = 0.008$$

$$ft2 = 886.8103$$

$$fy2 = 739.0086$$

$$su2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/l_b, \min = 1.00$$

$$su2 = 0.4 \cdot esu2_{\text{nominal}} ((5.5), \text{ TBDY}) = 0.032$$

$$\text{From table 5A.1, TBDY: } esu2_{\text{nominal}} = 0.08,$$

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

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

$$\text{with } fs2 = (fs_{\text{jacket}} \cdot Asl, \text{com, jacket} + fs_{\text{core}} \cdot Asl, \text{com, core}) / Asl, \text{com} = 739.0086$$

$$\text{with } Es2 = (Es_{\text{jacket}} \cdot Asl, \text{com, jacket} + Es_{\text{core}} \cdot Asl, \text{com, core}) / Asl, \text{com} = 200000.00$$

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 895.9746$$

$$fyv = 746.6455$$

$$suv = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$l_o/l_o, \min = l_b/d = 1.00$
 $s_{uv} = 0.4 * e_{suv_nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $e_{suv_nominal} = 0.08$,
 considering characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY
 For calculation of $e_{suv_nominal}$ and y_v , sh_v, ft_v, f_{yv} , it is considered
 characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY.
 y_1 , sh_1, ft_1, f_{y1} , are also multiplied by $\text{Min}(1, 1.25 * (l_b/d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{sv} = (f_{s,jacket} * A_{s,mid,jacket} + f_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 746.6455$
 with $E_{sv} = (E_{s,jacket} * A_{s,mid,jacket} + E_{s,mid} * A_{s,mid,core}) / A_{s,mid} = 200000.00$
 $1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.09382814$
 $2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.09382814$
 $v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.05785932$

and confined core properties:

$b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 30.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{s,ten} / (b * d) * (f_{s1} / f_c) = 0.11251192$
 $2 = A_{s,com} / (b * d) * (f_{s2} / f_c) = 0.11251192$
 $v = A_{s,mid} / (b * d) * (f_{sv} / f_c) = 0.06938071$

Case/Assumption: Unconfined full section - Steel rupture
 ' does not satisfy Eq. (4.3)

--->

$v < v_{s,c}$ - RHS eq.(4.5) is satisfied

--->

$su (4.9) = 0.1468828$
 $Mu = MR_c (4.14) = 3.2725E+008$
 $u = su (4.1) = 0.00010507$

Calculation of ratio l_b/d

Adequate Lap Length: $l_b/d \geq 1$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 390183.487$

Calculation of Shear Strength at edge 1, $V_{r1} = 390183.487$
 $V_{r1} = V_n ((22.5.1.1), \text{ACI } 318-14)$

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f * V_f$ '
 where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 180743.977$
 $= 1$ (normal-weight concrete)
 Mean concrete strength: $f'_c = (f'_{c,jacket} * \text{Area}_{jacket} + f'_{c,core} * \text{Area}_{core}) / \text{Area}_{section} = 27.76119$, but $f'_c^{0.5} < =$
 8.3 MPa (22.5.3.1, ACI 318-14)
 $p_w = A_s / (b_w * d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 670.00$
 $d = 320.00$
 $V_u * d / Mu < 1 = 0.00$
 $Mu = 6.8565666E-012$
 $V_u = 9.0372119E-015$
 From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 209439.51$
 $V_{s1} = 209439.51$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 625.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17, 10.3.4)
 $V_{s2} = 0.00$ is calculated for jacket, with:
 $d_2 = 160.00$

$$A_v = 100530.965$$

$$f_y = 525.00$$

$$s = 300.00$$

Vs2 is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)

$$V_f ((11-3)-(11.4), \text{ACI 440}) = 0.00$$

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 750430.726$$

Calculation of Shear Strength at edge 2, $V_{r2} = 390183.487$

$$V_{r2} = V_n ((22.5.1.1), \text{ACI 318-14})$$

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw + f*Vf'

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

$$\text{From Table (22.5.5.1), ACI 318-14: } V_c = 180743.977$$

= 1 (normal-weight concrete)

$$\text{Mean concrete strength: } f'_c = (f'_c_{\text{jacket}} * \text{Area}_{\text{jacket}} + f'_c_{\text{core}} * \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 27.76119, \text{ but } f'_c^{0.5} \leq 8.3 \text{ MPa (22.5.3.1, ACI 318-14)}$$

$$p_w = A_s / (b_w * d) = 0.00331157$$

$$A_s (\text{tension reinf.}) = 709.9999$$

$$b_w = 670.00$$

$$d = 320.00$$

$$V_u * d / M_u < 1 = 0.00$$

$$M_u = 2.0256286 \text{E-}011$$

$$V_u = 9.0372119 \text{E-}015$$

$$\text{From (11.5.4.8), ACI 318-14: } V_{s1} + V_{s2} = 209439.51$$

$V_{s1} = 209439.51$ is calculated for jacket, with:

$$d = 320.00$$

$$A_v = 157079.633$$

$$f_y = 625.00$$

$$s = 150.00$$

Vs1 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

Vs2 = 0.00 is calculated for jacket, with:

$$d = 160.00$$

$$A_v = 100530.965$$

$$f_y = 525.00$$

$$s = 300.00$$

Vs2 is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)

$$V_f ((11-3)-(11.4), \text{ACI 440}) = 0.00$$

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 750430.726$$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (b)

Section Type: rcjars

Constant Properties

$$\text{Knowledge Factor, } \phi = 0.87$$

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

$$\text{New material of Secondary Member: Concrete Strength, } f_c = f_{cm} = 30.00$$

$$\text{New material of Secondary Member: Steel Strength, } f_s = f_{sm} = 625.00$$

$$\text{Concrete Elasticity, } E_c = 25742.96$$

$$\text{Steel Elasticity, } E_s = 200000.00$$

Existing Column

$$\text{Existing material of Secondary Member: Concrete Strength, } f_c = f_{cm} = 24.00$$

$$\text{Existing material of Secondary Member: Steel Strength, } f_s = f_{sm} = 525.00$$

$$\text{Concrete Elasticity, } E_c = 23025.204$$

$$\text{Steel Elasticity, } E_s = 200000.00$$

External Height, H = 670.00
 External Width, W = 400.00
 Internal Height, H = 500.00
 Internal Width, W = 200.00
 Cover Thickness, c = 25.00
 Element Length, L = 3000.00
 Secondary Member
 Smooth Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Adequate Lap Length ($l_b/d \geq 1$)
 No FRP Wrapping

Stepwise Properties

Bending Moment, M = 1.1729E+007
 Shear Force, V2 = -1.3365595E-014
 Shear Force, V3 = 15636.882
 Axial Force, F = -7187.067
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: Asl,t = 709.9999
 -Compression: Asl,c = 1668.186
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: Asl,ten = 709.9999
 -Compression: Asl,com = 1266.062
 -Middle: Asl,mid = 402.1239
 Longitudinal External Reinforcement Area Distribution (in 3 divisions)
 -Tension: Asl,ten,jacket = 402.1239
 -Compression: Asl,com,jacket = 804.2477
 -Middle: Asl,mid,jacket = 402.1239
 Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
 -Tension: Asl,ten,core = 307.8761
 -Compression: Asl,com,core = 461.8141
 -Middle: Asl,mid,core = 0.00
 Mean Diameter of Tension Reinforcement, DbL = 15.00

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = \frac{1}{2} u = 0.00953983$
 $u = \frac{1}{2} y + \frac{1}{2} p = 0.01096532$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.00096532$ ((4.29), Biskinis Phd))
 $M_y = 2.9231E+008$
 $L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 750.0686
 From table 10.5, ASCE 41_17: $E_{eff} = 0.3 * E_c * I_g = 7.5708E+013$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$
 $y_{ten} = 5.8234894E-006$
 with $f_y = 625.00$
 $d = 627.00$
 $y = 0.18846591$
 $A = 0.00953075$
 $B = 0.00408216$
 with $p_t = 0.00283094$
 $p_c = 0.00504809$

$p_v = 0.00160336$
 $N = 7187.067$
 $b = 400.00$
 $" = 0.06858054$
 $y_{comp} = 1.7825671E-005$
 with $f_c = 27.76119$
 $E_c = 25742.96$
 $y = 0.18768166$
 $A = 0.00941409$
 $B = 0.0040338$
 with $E_s = 200000.00$

Calculation of ratio I_b/I_d

Adequate Lap Length: $I_b/I_d \geq 1$

- Calculation of p -

From table 10-7: $p = 0.01$

with:

- Condition i occurred
- Beam controlled by flexure: $V_p/V_o \leq 1$
- shear control ratio $V_p/V_o = 0.92480584$
- Transverse Reinforcement: C
- Stirrup Spacing $\leq d/3$
- Low ductility demand, $\gamma < 2$ (table 10-6, ASCE 41-17)
- $= 4.9940864E-006$
- Stirrup Spacing $\leq d/2$
- $d = d_{external} = 627.00$
- $s = s_{external} = 150.00$
- Strength provided by hoops $V_s < 3/4 \times \text{design Shear}$
- $V_s = 421182.855$, already given in calculation of shear control ratio
- design Shear = 15636.882
- $(\rho_t - \rho_c)/\rho_{bal} = -0.3178459$
- $= A_{st}/(b_w \times d) = 0.00283094$
- Tension Reinf Area: $A_{st} = 709.9999$
- $\rho_c = A_{sc}/(b_w \times d) = 0.00665146$
- Compression Reinf Area: $A_{sc} = 1668.186$
- From (B-1), ACI 318-11: $\rho_{bal} = 0.01202003$
- $f_c = (f_{c_jacket} \times \text{Area}_{jacket} + f_{c_core} \times \text{Area}_{core}) / \text{section_area} = 27.76119$
- $f_y = f_{y_jacket_bars} = 625.00$
- From 10.2.7.3, ACI 318-11: $\beta_1 = 0.65$
- From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000/(87000 + f_y) = c_b/d_t = 0.003/(0.003 + \gamma) = 0.48979592$
- $\gamma = 0.003125$
- $V/(b_w \times d \times f_c^{0.5}) = 0.14250391$, NOTE: units in I_b & in
- $b_w = 400.00$

End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (b)

Calculation No. 7

beam B1, Floor 1

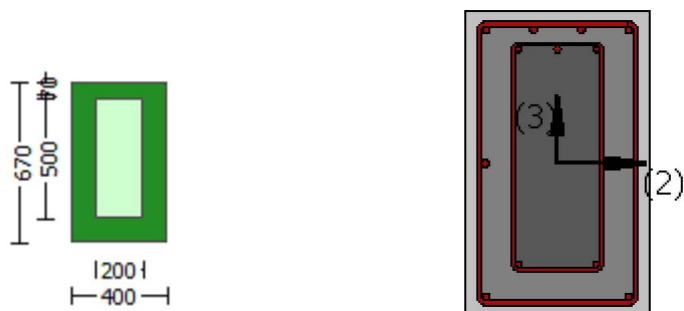
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: End

Local Axis: (3)



Start Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (b)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 0.87$

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, $f_c = f_{c_lower_bound} = 20.00$

New material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 420.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_o/l_{ou,min} = l_b/l_d \geq 1$)

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 5.6604\text{E}+006$

Shear Force, $V_a = 4044.385$

EDGE -B-

Bending Moment, $M_b = 1.1729\text{E}+007$

Shear Force, $V_b = 15636.882$

BOTH EDGES

Axial Force, $F = -7187.067$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 709.9999$

-Compression: $As_c = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten} = 709.9999$

-Compression: $As_{c,com} = 1266.062$

-Middle: $As_{mid} = 402.1239$

Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 15.00$

Existing component: From table 7-7, ASCE 41-17: Final Shear Capacity $VR = \phi V_n = 404549.731$

V_n ((22.5.1.1), ACI 318-14) = 464999.69

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + \phi V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 156202.077$

= 1 (normal-weight concrete)

Mean concrete strength: $fc' = (fc'_{jacket} \cdot Area_{jacket} + fc'_{core} \cdot Area_{core}) / Area_{section} = 18.50746$, but $fc'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$\rho_w = As / (b_w \cdot d) = 0.00331157$

As (tension reinf.) = 709.9999

$b_w = 400.00$

$d = 536.00$

$V_u \cdot d / M_u < 1 = 0.71460132$

$M_u = 1.1729\text{E}+007$

$V_u = 15636.882$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 308797.614$

$V_{s1} = 280648.944$ is calculated for jacket, with:

$d = 536.00$

$A_v = 157079.633$

$f_y = 500.00$

$s = 150.00$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 28148.67$ is calculated for core, with:

$d = 400.00$

$A_v = 100530.965$

$f_y = 420.00$

$s = 300.00$

V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.50$

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

From (11-11), ACI 440: $V_s + V_f \leq 612724.122$

End Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (b)

Calculation No. 8

beam B1, Floor 1

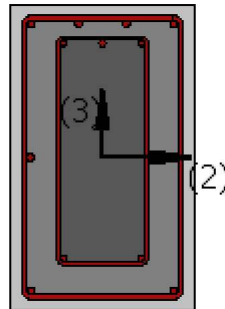
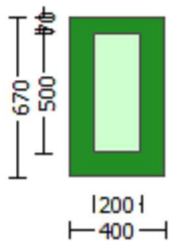
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (ϕ)

Edge: End

Local Axis: (3)



Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\phi = 0.87$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

#####

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, $f_s = 1.25 \cdot f_{sm} = 781.25$

Existing Column

Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 656.25$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$
Mean Confinement Factor overall section = 1.00
Element Length, $L = 3000.00$
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length ($l_o/l_{ou}, \min \geq 1$)
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, $V_a = 9840.634$
EDGE -B-
Shear Force, $V_b = 9840.632$
BOTH EDGES
Axial Force, $F = -2309.833$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $As_t = 709.9999$
-Compression: $As_c = 1668.186$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $As_{t,ten} = 709.9999$
-Compression: $As_{c,com} = 1266.062$
-Middle: $As_{l,mid} = 402.1239$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.92480584$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 535287.788$
with
 $M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 7.8817E+008$
 $\mu_{u1+} = 4.6479E+008$, 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
 $\mu_{u1-} = 7.8817E+008$, 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
 $M_{pr2} = \max(\mu_{u2+}, \mu_{u2-}) = 7.8817E+008$
 $\mu_{u2+} = 4.6479E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the static loading combination
 $\mu_{u2-} = 7.8817E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination
and
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$
with
 $V_1 = 9840.634$, is the shear force acting at edge 1 for the static loading combination
 $V_2 = 9840.632$, is the shear force acting at edge 2 for the static loading combination

Calculation of μ_{u1+}

Calculation of ultimate curvature μ_u according to 4.1, Biskinis/Fardis 2013:
 $\mu_u = 5.6369735E-005$
 $\mu_u = 4.6479E+008$

with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.000307$
 $N = 2309.833$

$f_c = 30.00$
 $c_o (5A.5, TBDY) = 0.002$
 Final value of c_u : $c_u^* = \text{shear_factor} * \text{Max}(c_u, c_o) = 0.0053097$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $c_u = 0.0053097$
 $w_e (5.4c) = 0.00204688$
 $a_{se} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$
 $a_{se1} = 0.14776895$
 $b_o_1 = 340.00$
 $h_o_1 = 610.00$
 $b_{i2_1} = 975400.00$
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$
 $b_o_2 = 192.00$
 $h_o_2 = 492.00$
 $b_{i2_2} = 557856.00$
 $p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.38519$
 Expression ((5.4d), TBDY) for $p_{sh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.45559$
 $p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h_1 = 670.00$
 $p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirrups, $n_{s_2} = 2.00$
 $h_2 = 500.00$

$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.38519$
 $p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h_1 = 400.00$
 $p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirrups, $n_{s_2} = 2.00$
 $h_2 = 200.00$

$A_{sec} = 268000.00$
 $s_1 = 150.00$
 $s_2 = 300.00$
 $f_{ywe1} = 781.25$
 $f_{ywe2} = 656.25$
 $f_{ce} = 30.00$

From ((5.A5), TBDY), TBDY: $c_c = 0.002$
 $c = \text{confinement factor} = 1.00$

$y_1 = 0.0025$
 $sh_1 = 0.008$
 $ft_1 = 872.4558$
 $fy_1 = 727.0465$
 $su_1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$l_o / l_{ou, \min} = l_b / l_d = 1.00$

$su_1 = 0.4 * esu_{1_nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esu_{1_nominal} = 0.08$,

For calculation of $esu_{1_nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered
 characteristic value $fsy_1 = fs_1 / 1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b / l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs_1 = (f_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + f_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 727.0465$

with $Es_1 = (E_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + E_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 200000.00$

$y_2 = 0.0025$
 $sh_2 = 0.008$
 $ft_2 = 882.7854$
 $fy_2 = 735.6545$

```

su2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lo,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 735.6545
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 937.50
fyv = 781.25
suv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lo,min = lb/ld = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 781.25
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06860752
2 = Asl,com/(b*d)*(fs2/fc) = 0.12378842
v = Asl,mid/(b*d)*(fsv/fc) = 0.04175429
and confined core properties:
b = 340.00
d = 597.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.08477074
2 = Asl,com/(b*d)*(fs2/fc) = 0.15295169
v = Asl,mid/(b*d)*(fsv/fc) = 0.05159117
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.09460844
Mu = MRc (4.14) = 4.6479E+008
u = su (4.1) = 5.6369735E-005

```

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

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

u = 6.0907698E-005
Mu = 7.8817E+008

with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.000307$
 $N = 2309.833$
 $f_c = 30.00$
 $\phi (5A.5, \text{TB DY}) = 0.002$
 Final value of ϕ : $\phi^* = \text{shear_factor} * \text{Max}(\phi_c, \phi_s) = 0.0053097$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TB DY: $\phi_c = 0.0053097$
 $\phi_s (5.4c) = 0.00204688$
 $\phi_{se} ((5.4d), \text{TB DY}) = (\phi_{se1} * A_{ext} + \phi_{se2} * A_{int}) / A_{sec} = 0.14776895$
 $\phi_{se1} = 0.14776895$
 $b_{o_1} = 340.00$
 $h_{o_1} = 610.00$
 $b_{i2_1} = 975400.00$
 $\phi_{se2} = \text{Max}(\phi_{se1}, \phi_{se2}) = 0.14776895$
 $b_{o_2} = 192.00$
 $h_{o_2} = 492.00$
 $b_{i2_2} = 557856.00$
 $\phi_{sh, \min} * F_{ywe} = \text{Min}(\phi_{sh, x} * F_{ywe}, \phi_{sh, y} * F_{ywe}) = 1.38519$
 Expression ((5.4d), TB DY) for $\phi_{sh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$\phi_{sh, x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.45559$
 $\phi_{sh1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h_1 = 670.00$
 $\phi_{sh2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirrups, $n_{s_2} = 2.00$
 $h_2 = 500.00$

$\phi_{sh, y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.38519$
 $\phi_{sh1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h_1 = 400.00$
 $\phi_{sh2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirrups, $n_{s_2} = 2.00$
 $h_2 = 200.00$

$A_{sec} = 268000.00$
 $s_1 = 150.00$
 $s_2 = 300.00$
 $f_{ywe1} = 781.25$
 $f_{ywe2} = 656.25$
 $f_{ce} = 30.00$
 From ((5.A5), TB DY), TB DY: $\phi_c = 0.002$
 $\phi_c = \text{confinement factor} = 1.00$
 $y_1 = 0.0025$
 $sh_1 = 0.008$
 $ft_1 = 882.7854$
 $fy_1 = 735.6545$
 $su_1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o / l_{ou, \min} = l_b / l_d = 1.00$
 $su_1 = 0.4 * esu_{1_nominal} ((5.5), \text{TB DY}) = 0.032$
 From table 5A.1, TB DY: $esu_{1_nominal} = 0.08$,
 For calculation of $esu_{1_nominal}$ and y_1 , sh_1 , ft_1 , fy_1 , it is considered
 characteristic value $fsy_1 = fs_1 / 1.2$, from table 5.1, TB DY.
 y_1 , sh_1 , ft_1 , fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b / l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_1 = (f_s, \text{jacket} * A_{sl, \text{ten, jacket}} + f_s, \text{core} * A_{sl, \text{ten, core}}) / A_{sl, \text{ten}} = 735.6545$

```

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 872.4558
fy2 = 727.0465
su2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 727.0465
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 937.50
fyv = 781.25
suv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 781.25
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.12378842
2 = Asl,com/(b*d)*(fs2/fc) = 0.06860752
v = Asl,mid/(b*d)*(fsv/fc) = 0.04175429
and confined core properties:
b = 340.00
d = 597.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.15295169
2 = Asl,com/(b*d)*(fs2/fc) = 0.08477074
v = Asl,mid/(b*d)*(fsv/fc) = 0.05159117
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.8) = 0.16206515
Mu = MRc (4.15) = 7.8817E+008
u = su (4.1) = 6.0907698E-005

```

Calculation of ratio lb/lb

Adequate Lap Length: lb/lb >= 1

Calculation of Mu2+

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

$$u = 5.6369735E-005$$

$$\mu = 4.6479E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.000307$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$\alpha (5A.5, \text{TBDY}) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.0053097$$

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

$$\text{From (5.4b), TBDY: } \phi_u = 0.0053097$$

$$\phi_{ue} (5.4c) = 0.00204688$$

$$\alpha_{se} ((5.4d), \text{TBDY}) = (\alpha_{se1} * A_{ext} + \alpha_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$\alpha_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$\alpha_{se2} = \text{Max}(\alpha_{se1}, \alpha_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$\phi_{sh,min} * F_{ywe} = \text{Min}(\phi_{sh,x} * F_{ywe}, \phi_{sh,y} * F_{ywe}) = 1.38519$$

Expression ((5.4d), TBDY) for $\phi_{sh,min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\phi_{sh,x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.45559$$

$$\phi_{sh1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$\phi_{sh2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$\phi_{sh,y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.38519$$

$$\phi_{sh1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$\phi_{sh2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 872.4558$$

$$fy_1 = 727.0465$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00


```

lo/lou,min = lb/d = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 727.0465
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 882.7854
fy2 = 735.6545
su2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 735.6545
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 937.50
fyv = 781.25
suv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 781.25
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06860752
2 = Asl,com/(b*d)*(fs2/fc) = 0.12378842
v = Asl,mid/(b*d)*(fsv/fc) = 0.04175429
and confined core properties:
b = 340.00
d = 597.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.08477074
2 = Asl,com/(b*d)*(fs2/fc) = 0.15295169
v = Asl,mid/(b*d)*(fsv/fc) = 0.05159117
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.09460844
Mu = MRc (4.14) = 4.6479E+008
u = su (4.1) = 5.6369735E-005

```

Calculation of ratio lb/d

Adequate Lap Length: lb/d >= 1

Calculation of Mu2-

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

$$\mu = 6.0907698E-005$$

$$Mu = 7.8817E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.000307$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$cc \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } \mu: \mu^* = \text{shear_factor} * \text{Max}(\mu, cc) = 0.0053097$$

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

$$\text{From (5.4b), TBDY: } \mu = 0.0053097$$

$$w_e \text{ (5.4c)} = 0.00204688$$

$$ase \text{ ((5.4d), TBDY)} = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$$

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

$$ho_1 = 610.00$$

$$bi2_1 = 975400.00$$

$$ase2 = \text{Max}(ase1, ase2) = 0.14776895$$

$$bo_2 = 192.00$$

$$ho_2 = 492.00$$

$$bi2_2 = 557856.00$$

$$psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.38519$$

Expression ((5.4d), TBDY) for $psh_{min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.45559$$

$$ps1 \text{ (external)} = (Ash1 * h1 / s1) / A_{sec} = 0.00261799$$

$$Ash1 = Astir_1 * ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h1 = 670.00$$

$$ps2 \text{ (internal)} = (Ash2 * h2 / s2) / A_{sec} = 0.00062519$$

$$Ash2 = Astir_2 * ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h2 = 500.00$$

$$psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.38519$$

$$ps1 \text{ (external)} = (Ash1 * h1 / s1) / A_{sec} = 0.00156298$$

$$Ash1 = Astir_1 * ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h1 = 400.00$$

$$ps2 \text{ (internal)} = (Ash2 * h2 / s2) / A_{sec} = 0.00025008$$

$$Ash2 = Astir_2 * ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fy_{we1} = 781.25$$

$$fy_{we2} = 656.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TBDY), TBDY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 882.7854$$

```

fy1 = 735.6545
su1 = 0.032
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb = 1.00
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 735.6545
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 872.4558
fy2 = 727.0465
su2 = 0.032
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 1.00
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 727.0465
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 937.50
fyv = 781.25
suv = 0.032
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb = 1.00
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 781.25
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.12378842
2 = Asl,com/(b*d)*(fs2/fc) = 0.06860752
v = Asl,mid/(b*d)*(fsv/fc) = 0.04175429
and confined core properties:
b = 340.00
d = 597.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.15295169
    2 = Asl,com/(b*d)*(fs2/fc) = 0.08477074
    v = Asl,mid/(b*d)*(fsv/fc) = 0.05159117
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
---->
v < vs,y2 - LHS eq.(4.5) is not satisfied
---->
v < vs,c - RHS eq.(4.5) is satisfied
---->
su (4.8) = 0.16206515

```

$$\begin{aligned}\mu &= MRC(4.15) = 7.8817E+008 \\ u &= su(4.1) = 6.0907698E-005\end{aligned}$$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of Shear Strength $V_r = \min(V_{r1}, V_{r2}) = 578810.994$

Calculation of Shear Strength at edge 1, $V_{r1} = 578810.994$

$V_{r1} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f_v V_f$ ' where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 192813.976$
 $= 1$ (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_c_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f'_c_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 27.76119$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 400.00$
 $d = 536.00$
 $V_u \cdot d / \mu < 1 = 1.00$
 $\mu = 1.1510E+006$
 $V_u = 9840.634$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 385997.017$
 $V_{s1} = 350811.18$ is calculated for jacket, with:
 $d = 536.00$
 $A_v = 157079.633$
 $f_y = 625.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17, 10.3.4)
 $V_{s2} = 35185.838$ is calculated for jacket, with:
 $d_2 = 400.00$
 $A_v = 100530.965$
 $f_y = 525.00$
 $s = 300.00$
 V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17, 10.3.4)
 $2(1-s/d) = 0.50$
 V_f ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f \leq 750430.726$

Calculation of Shear Strength at edge 2, $V_{r2} = 578810.994$

$V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f_v V_f$ ' where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 192813.976$
 $= 1$ (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_c_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f'_c_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 27.76119$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 400.00$
 $d = 536.00$
 $V_u \cdot d / \mu < 1 = 1.00$
 $\mu = 1.1510E+006$
 $V_u = 9840.632$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 385997.017$
 $V_{s1} = 350811.18$ is calculated for jacket, with:
 $d = 536.00$

Av = 157079.633

fy = 625.00

s = 150.00

Vs1 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

Vs2 = 35185.838 is calculated for jacket, with:

d = 400.00

Av = 100530.965

fy = 525.00

s = 300.00

Vs2 has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.50$

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

From (11-11), ACI 440: $Vs + Vf \leq 750430.726$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 2

(Bending local axis: 3)

Section Type: rcjars

Constant Properties

Knowledge Factor, = 0.87

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

#####

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, $f_s = 1.25 \cdot f_{sm} = 781.25$

Existing Column

Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 656.25$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_o/l_{ou}, \min > 1$)

No FRP Wrapping

Stepwise Properties

At local axis: 2

EDGE -A-
 Shear Force, $V_a = -9.0372119\text{E-}015$
 EDGE -B-
 Shear Force, $V_b = 9.0372119\text{E-}015$
 BOTH EDGES
 Axial Force, $F = -2309.833$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $A_{st} = 709.9999$
 -Compression: $A_{sc} = 1668.186$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $A_{st,ten} = 911.0619$
 -Compression: $A_{sc,com} = 911.0619$
 -Middle: $A_{st,mid} = 556.0619$

 Calculation of Shear Capacity ratio , $V_e/V_r = 0.55914272$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 218168.257$
 with
 $M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 3.2725\text{E+}008$
 $Mu_{1+} = 3.2725\text{E+}008$, 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
 $Mu_{1-} = 3.2725\text{E+}008$, 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
 $M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 3.2725\text{E+}008$
 $Mu_{2+} = 3.2725\text{E+}008$, 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
 $Mu_{2-} = 3.2725\text{E+}008$, 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
 and
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$
 with
 $V_1 = -9.0372119\text{E-}015$, is the shear force acting at edge 1 for the the static loading combination
 $V_2 = 9.0372119\text{E-}015$, is the shear force acting at edge 2 for the the static loading combination

 Calculation of Mu_{1+}

 Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 0.00010507$
 $M_u = 3.2725\text{E+}008$

with full section properties:

$b = 670.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.0003219$
 $N = 2309.833$
 $f_c = 30.00$
 ϕ_c (5A.5, TBDY) = 0.002
 Final value of ϕ_u : $\phi_u^* = \text{shear_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.0053097$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $\phi_u = 0.0053097$
 w_e (5.4c) = 0.00204688
 a_{se} ((5.4d), TBDY) = $(a_{se1} \cdot A_{ext} + a_{se2} \cdot A_{int})/A_{sec} = 0.14776895$
 $a_{se1} = 0.14776895$
 $bo_1 = 340.00$
 $ho_1 = 610.00$
 $bi2_1 = 975400.00$
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi2_2 = 557856.00$

$psh,min*Fywe = \text{Min}(psh,x*Fywe, psh,y*Fywe) = 1.38519$
 Expression ((5.4d), TBDY) for $psh,min*Fywe$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh_x*Fywe = psh1*Fywe1 + ps2*Fywe2 = 2.45559$
 $ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00261799$
 $Ash1 = Astir_1*ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 670.00$
 $ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00062519$
 $Ash2 = Astir_2*ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 500.00$

$psh_y*Fywe = psh1*Fywe1 + ps2*Fywe2 = 1.38519$
 $ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00156298$
 $Ash1 = Astir_1*ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00025008$
 $Ash2 = Astir_2*ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

$Asec = 268000.00$
 $s1 = 150.00$
 $s2 = 300.00$
 $fywe1 = 781.25$
 $fywe2 = 656.25$
 $fce = 30.00$

From ((5.A5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$

$y1 = 0.0025$
 $sh1 = 0.008$
 $ft1 = 886.8103$
 $fy1 = 739.0086$
 $su1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/ld = 1.00$

$su1 = 0.4*esu1_nominal \text{ ((5.5), TBDY)} = 0.032$

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

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

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

with $fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 739.0086$

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

$y2 = 0.0025$
 $sh2 = 0.008$
 $ft2 = 886.8103$
 $fy2 = 739.0086$
 $su2 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lou,min = lb/lb,min = 1.00$

$su2 = 0.4*esu2_nominal \text{ ((5.5), TBDY)} = 0.032$

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

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

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

with $fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 739.0086$

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

$yv = 0.0025$
 $shv = 0.008$
 $ftv = 895.9746$

```

fyv = 746.6455
suv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lo,min = lb/ld = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fsjacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 746.6455
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09382814
2 = Asl,com/(b*d)*(fs2/fc) = 0.09382814
v = Asl,mid/(b*d)*(fsv/fc) = 0.05785932
and confined core properties:
b = 610.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11251192
2 = Asl,com/(b*d)*(fs2/fc) = 0.11251192
v = Asl,mid/(b*d)*(fsv/fc) = 0.06938071
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.9) = 0.1468828
Mu = MRc (4.14) = 3.2725E+008
u = su (4.1) = 0.00010507

```

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

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

```

u = 0.00010507
Mu = 3.2725E+008

```

with full section properties:

```

b = 670.00
d = 357.00
d' = 43.00
v = 0.0003219
N = 2309.833
fc = 30.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.0053097
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0053097
we (5.4c) = 0.00204688
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.14776895
ase1 = 0.14776895
bo_1 = 340.00
ho_1 = 610.00

```


$bi2_1 = 975400.00$
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi2_2 = 557856.00$
 $psh, \min * Fywe = \text{Min}(psh, x * Fywe, psh, y * Fywe) = 1.38519$
 Expression ((5.4d), TBDY) for $psh, \min * Fywe$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh_x * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 2.45559$
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.00261799$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 670.00$
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00062519$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 500.00$

$psh_y * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 1.38519$
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.00156298$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00025008$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

$Asec = 268000.00$
 $s1 = 150.00$
 $s2 = 300.00$
 $fywe1 = 781.25$
 $fywe2 = 656.25$
 $fce = 30.00$

From ((5.A5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$

$y1 = 0.0025$
 $sh1 = 0.008$
 $ft1 = 886.8103$
 $fy1 = 739.0086$
 $su1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lou, \min = lb/l_d = 1.00$

$su1 = 0.4 * esu1_nominal \text{ ((5.5), TBDY)} = 0.032$

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

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

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

with $fs1 = (fs, \text{jacket} * Asl, \text{ten, jacket} + fs, \text{core} * Asl, \text{ten, core}) / Asl, \text{ten} = 739.0086$

with $Es1 = (Es, \text{jacket} * Asl, \text{ten, jacket} + Es, \text{core} * Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$

$y2 = 0.0025$
 $sh2 = 0.008$
 $ft2 = 886.8103$
 $fy2 = 739.0086$
 $su2 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lou, \min = lb/l_b, \min = 1.00$

$su2 = 0.4 * esu2_nominal \text{ ((5.5), TBDY)} = 0.032$

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

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

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

```

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 739.0086
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 895.9746
fyv = 746.6455
suv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 746.6455
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09382814
2 = Asl,com/(b*d)*(fs2/fc) = 0.09382814
v = Asl,mid/(b*d)*(fsv/fc) = 0.05785932
and confined core properties:
b = 610.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11251192
2 = Asl,com/(b*d)*(fs2/fc) = 0.11251192
v = Asl,mid/(b*d)*(fsv/fc) = 0.06938071
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.9) = 0.1468828
Mu = MRc (4.14) = 3.2725E+008
u = su (4.1) = 0.00010507

```

Calculation of ratio lb/d

Adequate Lap Length: lb/d >= 1

Calculation of Mu2+

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

```

u = 0.00010507
Mu = 3.2725E+008

```

with full section properties:

```

b = 670.00
d = 357.00
d' = 43.00
v = 0.0003219
N = 2309.833
fc = 30.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.0053097
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0053097

```

$w_e (5.4c) = 0.00204688$
 $ase ((5.4d), TBDY) = (ase1 \cdot A_{ext} + ase2 \cdot A_{int}) / A_{sec} = 0.14776895$
 $ase1 = 0.14776895$
 $bo_1 = 340.00$
 $ho_1 = 610.00$
 $bi2_1 = 975400.00$
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi2_2 = 557856.00$

$psh, min \cdot F_{ywe} = \text{Min}(psh, x \cdot F_{ywe}, psh, y \cdot F_{ywe}) = 1.38519$
 Expression ((5.4d), TBDY) for $psh, min \cdot F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh, x \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 2.45559$
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / A_{sec} = 0.00261799$
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 670.00$
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / A_{sec} = 0.00062519$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 500.00$

$psh, y \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 1.38519$
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / A_{sec} = 0.00156298$
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / A_{sec} = 0.00025008$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

$A_{sec} = 268000.00$

$s1 = 150.00$

$s2 = 300.00$

$fywe1 = 781.25$

$fywe2 = 656.25$

$f_{ce} = 30.00$

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

$c = \text{confinement factor} = 1.00$

$y1 = 0.0025$

$sh1 = 0.008$

$ft1 = 886.8103$

$fy1 = 739.0086$

$su1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$lo/lo, min = lb/ld = 1.00$

$su1 = 0.4 \cdot esu1_nominal ((5.5), TBDY) = 0.032$

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

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

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

with $fs1 = (fs, jacket \cdot A_{sl, ten, jacket} + fs, core \cdot A_{sl, ten, core}) / A_{sl, ten} = 739.0086$

with $Es1 = (Es, jacket \cdot A_{sl, ten, jacket} + Es, core \cdot A_{sl, ten, core}) / A_{sl, ten} = 200000.00$

$y2 = 0.0025$

$sh2 = 0.008$

$ft2 = 886.8103$

$fy2 = 739.0086$

$su2 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$lo/lo, min = lb/lb, min = 1.00$

```

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 739.0086
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 895.9746
fyv = 746.6455
suv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 746.6455
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09382814
2 = Asl,com/(b*d)*(fs2/fc) = 0.09382814
v = Asl,mid/(b*d)*(fsv/fc) = 0.05785932
and confined core properties:
b = 610.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11251192
2 = Asl,com/(b*d)*(fs2/fc) = 0.11251192
v = Asl,mid/(b*d)*(fsv/fc) = 0.06938071
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.9) = 0.1468828
Mu = MRc (4.14) = 3.2725E+008
u = su (4.1) = 0.00010507

```

Calculation of ratio lb/d

Adequate Lap Length: lb/d >= 1

Calculation of Mu2-

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

```

u = 0.00010507
Mu = 3.2725E+008

```

with full section properties:

```

b = 670.00
d = 357.00
d' = 43.00
v = 0.0003219
N = 2309.833

```

$f_c = 30.00$
 $c_o (5A.5, TBDY) = 0.002$
 Final value of c_u : $c_u^* = \text{shear_factor} * \text{Max}(c_u, c_o) = 0.0053097$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $c_u = 0.0053097$
 $w_e (5.4c) = 0.00204688$
 $a_{se} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$
 $a_{se1} = 0.14776895$
 $b_o_1 = 340.00$
 $h_o_1 = 610.00$
 $b_{i2_1} = 975400.00$
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$
 $b_o_2 = 192.00$
 $h_o_2 = 492.00$
 $b_{i2_2} = 557856.00$
 $p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.38519$
 Expression ((5.4d), TBDY) for $p_{sh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.45559$
 $p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h_1 = 670.00$
 $p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirrups, $n_{s_2} = 2.00$
 $h_2 = 500.00$

$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.38519$
 $p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h_1 = 400.00$
 $p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirrups, $n_{s_2} = 2.00$
 $h_2 = 200.00$

$A_{sec} = 268000.00$
 $s_1 = 150.00$
 $s_2 = 300.00$
 $f_{ywe1} = 781.25$
 $f_{ywe2} = 656.25$
 $f_{ce} = 30.00$

From ((5.A5), TBDY), TBDY: $c_c = 0.002$
 $c = \text{confinement factor} = 1.00$

$y_1 = 0.0025$
 $sh_1 = 0.008$
 $ft_1 = 886.8103$
 $fy_1 = 739.0086$
 $su_1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$l_o / l_{ou, \min} = l_b / l_d = 1.00$

$su_1 = 0.4 * esu_{1_nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esu_{1_nominal} = 0.08$,

For calculation of $esu_{1_nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered
 characteristic value $fsy_1 = fs_1 / 1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b / l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs_1 = (f_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + f_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 739.0086$

with $Es_1 = (E_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + E_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 200000.00$

$y_2 = 0.0025$
 $sh_2 = 0.008$
 $ft_2 = 886.8103$
 $fy_2 = 739.0086$

```

su2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 739.0086
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 895.9746
fyv = 746.6455
suv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 746.6455
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09382814
2 = Asl,com/(b*d)*(fs2/fc) = 0.09382814
v = Asl,mid/(b*d)*(fsv/fc) = 0.05785932
and confined core properties:
b = 610.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11251192
2 = Asl,com/(b*d)*(fs2/fc) = 0.11251192
v = Asl,mid/(b*d)*(fsv/fc) = 0.06938071
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.9) = 0.1468828
Mu = MRc (4.14) = 3.2725E+008
u = su (4.1) = 0.00010507

```

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Shear Strength $V_r = \min(V_{r1}, V_{r2}) = 390183.487$

Calculation of Shear Strength at edge 1, $V_{r1} = 390183.487$
 $V_{r1} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f*Vf'
 where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 180743.977$
 $= 1$ (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot Area_jacket + f'_{c_core} \cdot Area_core) / Area_section = 27.76119$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 670.00$
 $d = 320.00$
 $V_u \cdot d / M_u < 1 = 0.00$
 $M_u = 6.8565666E-012$
 $V_u = 9.0372119E-015$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 209439.51$
 $V_{s1} = 209439.51$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 625.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 0.00$ is calculated for jacket, with:
 $d/2 = 160.00$
 $A_v = 100530.965$
 $f_y = 525.00$
 $s = 300.00$
 V_{s2} is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)
 V_f ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f \leq 750430.726$

Calculation of Shear Strength at edge 2, $V_{r2} = 390183.487$
 $V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 180743.977$
 $= 1$ (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot Area_jacket + f'_{c_core} \cdot Area_core) / Area_section = 27.76119$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 670.00$
 $d = 320.00$
 $V_u \cdot d / M_u < 1 = 0.00$
 $M_u = 2.0256286E-011$
 $V_u = 9.0372119E-015$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 209439.51$
 $V_{s1} = 209439.51$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 625.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 0.00$ is calculated for jacket, with:
 $d/2 = 160.00$
 $A_v = 100530.965$
 $f_y = 525.00$
 $s = 300.00$
 V_{s2} is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)
 V_f ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f \leq 750430.726$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 3
Integration Section: (b)
Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 0.87$
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, $f_c = f_{cm} = 30.00$
New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$
Concrete Elasticity, $E_c = 25742.96$
Steel Elasticity, $E_s = 200000.00$
Existing Column
Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$
Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$
Concrete Elasticity, $E_c = 23025.204$
Steel Elasticity, $E_s = 200000.00$
External Height, $H = 670.00$
External Width, $W = 400.00$
Internal Height, $H = 500.00$
Internal Width, $W = 200.00$
Cover Thickness, $c = 25.00$
Element Length, $L = 3000.00$
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length ($l_b/d \geq 1$)
No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 2.3137405E-011$
Shear Force, $V_2 = -1.3365595E-014$
Shear Force, $V_3 = 15636.882$
Axial Force, $F = -7187.067$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $As_{lt} = 709.9999$
-Compression: $As_{lc} = 1668.186$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $As_{l,ten} = 911.0619$
-Compression: $As_{l,com} = 911.0619$
-Middle: $As_{l,mid} = 556.0619$
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: $As_{l,ten,jacket} = 603.1858$
-Compression: $As_{l,com,jacket} = 603.1858$
-Middle: $As_{l,mid,jacket} = 402.1239$
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
-Tension: $As_{l,ten,core} = 307.8761$
-Compression: $As_{l,com,core} = 307.8761$
-Middle: $As_{l,mid,core} = 153.938$
Mean Diameter of Tension Reinforcement, $Db_L = 15.20$

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_{l,R} = \gamma \cdot u = 0.00791936$
 $u = \gamma + p = 0.00910271$

- Calculation of γ -

$y = (M_y * L_s / 3) / E_{eff} = 0.00410271$ ((4.29), Biskinis Phd))
 $M_y = 2.1250E+008$
 $L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 1500.00
 From table 10.5, ASCE 41_17: $E_{eff} = 0.3 * E_c * I_g = 2.5898E+013$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$
 $y_{ten} = 1.0750434E-005$
 with $f_y = 625.00$
 $d = 357.00$
 $y = 0.22791811$
 $A = 0.00999336$
 $B = 0.00562082$
 with $p_t = 0.00380895$
 $p_c = 0.00380895$
 $p_v = 0.00232477$
 $N = 7187.067$
 $b = 670.00$
 $" = 0.12044818$
 $y_{comp} = 2.5846388E-005$
 with $f_c = 27.76119$
 $E_c = 25742.96$
 $y = 0.22733547$
 $A = 0.00987104$
 $B = 0.00557012$
 with $E_s = 200000.00$

Calculation of ratio I_b/I_d

Adequate Lap Length: $I_b/I_d \geq 1$

- Calculation of p -

From table 10-7: $p = 0.005$

with:

- Condition i occurred
- Beam controlled by flexure: $V_p/V_o \leq 1$
- shear control ratio $V_p/V_o = 0.55914272$
- Transverse Reinforcement: NC
- Stirrup Spacing $> d/3$
- Low ductility demand, $\phi_y < 2$ (table 10-6, ASCE 41-17)
 $= -1.8338097E-023$
- Stirrup Spacing $\leq d/2$
 $d = d_{external} = 357.00$
 $s = s_{external} = 150.00$
- Strength provided by hoops $V_s < 3/4 * \text{design Shear}$
 $V_s = 237588.18$, already given in calculation of shear control ratio
 design Shear = $1.3365595E-014$
- $(\phi - \phi') / \phi_{bal} = -0.33327376$
 $= A_{st} / (b_w * d) = 0.00296835$
 Tension Reinf Area: $A_{st} = 709.9999$
 $\phi' = A_{sc} / (b_w * d) = 0.00697431$
 Compression Reinf Area: $A_{sc} = 1668.186$
- From (B-1), ACI 318-11: $\phi_{bal} = 0.01202003$
 $f_c = (f_{c_jacket} * \text{Area_jacket} + f_{c_core} * \text{Area_core}) / \text{section_area} = 27.76119$
 $f_y = f_{y_jacket_bars} = 625.00$
 From 10.2.7.3, ACI 318-11: $\phi = 0.65$
 From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000 / (87000 + f_y) = c_b/d_t = 0.003 / (0.003 + \phi) = 0.48979592$
 $\phi = 0.003125$
- $V / (b_w * d * f_c^{0.5}) = 1.2771721E-019$, NOTE: units in lb & in

bw = 670.00

End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (b)

Calculation No. 9

beam B1, Floor 1

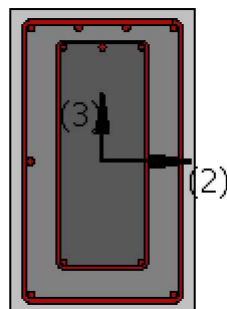
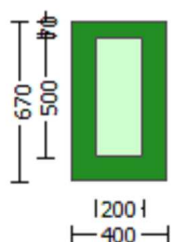
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (2)



Start Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 0.87$

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, $f_c = f_{c_lower_bound} = 20.00$

New material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 420.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$
 External Height, $H = 670.00$
 External Width, $W = 400.00$
 Internal Height, $H = 500.00$
 Internal Width, $W = 200.00$
 Cover Thickness, $c = 25.00$
 Element Length, $L = 3000.00$
 Secondary Member
 Smooth Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Adequate Lap Length ($l_o/l_{ou,min} = l_b/l_d \geq 1$)
 No FRP Wrapping

Stepwise Properties

EDGE -A-
 Bending Moment, $M_a = 2.8583610E-011$
 Shear Force, $V_a = 2.4489115E-014$
 EDGE -B-
 Bending Moment, $M_b = 4.4683392E-011$
 Shear Force, $V_b = -2.4489115E-014$
 BOTH EDGES
 Axial Force, $F = -9608.729$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $As_t = 709.9999$
 -Compression: $As_c = 1668.186$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten} = 911.0619$
 -Compression: $As_{c,com} = 911.0619$
 -Middle: $As_{mid} = 556.0619$
 Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 15.20$

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = V_n = 274161.749$
 V_n ((22.5.1.1), ACI 318-14) = 315128.448

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f^*V_f$ '
 where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 147576.839$
 = 1 (normal-weight concrete)
 Mean concrete strength: $f'_c = (f'_{c,jacket} \cdot Area_{jacket} + f'_{c,core} \cdot Area_{core}) / Area_{section} = 18.50746$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 670.00$
 $d = 320.00$
 $V_u \cdot d / M_u < 1 = 0.00$
 $M_u = 2.8583610E-011$
 $V_u = 2.4489115E-014$
 From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 167551.608$
 $V_{s1} = 167551.608$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 500.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17, 10.3.4)
 $V_{s2} = 0.00$ is calculated for core, with:
 $d = 160.00$
 $A_v = 100530.965$
 $f_y = 420.00$
 $s = 300.00$

Vs2 is considered 0 ($s > d$, according to ASCE 41-17, 10.3.4)

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

From (11-11), ACI 440: $V_s + V_f \leq 612724.122$

End Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (a)

Calculation No. 10

beam B1, Floor 1

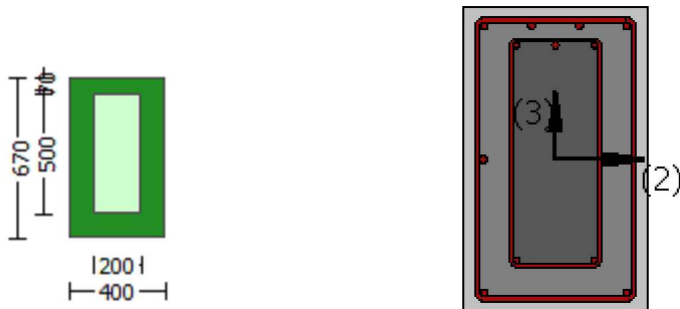
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (ϕ)

Edge: Start

Local Axis: (2)



Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\phi = 0.87$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

#####

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, $f_s = 1.25 \cdot f_{sm} = 781.25$

Existing Column

Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 656.25$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_o/l_{ou,min} \geq 1$)

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = 9840.634$

EDGE -B-

Shear Force, $V_b = 9840.632$

BOTH EDGES

Axial Force, $F = -2309.833$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 709.9999$

-Compression: $As_c = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten} = 709.9999$

-Compression: $As_{l,com} = 1266.062$

-Middle: $As_{l,mid} = 402.1239$

Calculation of Shear Capacity ratio , $V_e/V_r = 0.92480584$

Member Controlled by Flexure ($V_e/V_r < 1$)

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 535287.788$
with

$M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 7.8817\text{E}+008$

$\mu_{u1+} = 4.6479\text{E}+008$, 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

$\mu_{u1-} = 7.8817\text{E}+008$, 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

$M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 7.8817\text{E}+008$

$\mu_{u2+} = 4.6479\text{E}+008$, 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

$\mu_{u2-} = 7.8817\text{E}+008$, 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

and

$\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$

with

$V_1 = 9840.634$, is the shear force acting at edge 1 for the the static loading combination

$V_2 = 9840.632$, is the shear force acting at edge 2 for the the static loading combination

Calculation of μ_{u1+}

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

$$u = 5.6369735E-005$$

$$\mu = 4.6479E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.000307$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$\alpha (5A.5, \text{TBDY}) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.0053097$$

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

$$\text{From (5.4b), TBDY: } \phi_u = 0.0053097$$

$$\phi_{ue} \text{ (5.4c)} = 0.00204688$$

$$\phi_{se} \text{ ((5.4d), TBDY)} = (\phi_{se1} * A_{ext} + \phi_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$\phi_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$\phi_{se2} = \text{Max}(\phi_{se1}, \phi_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$\phi_{sh,min} * F_{ywe} = \text{Min}(\phi_{sh,x} * F_{ywe}, \phi_{sh,y} * F_{ywe}) = 1.38519$$

Expression ((5.4d), TBDY) for $\phi_{sh,min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\phi_{sh,x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.45559$$

$$\phi_{sh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$\phi_{sh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$\phi_{sh,y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.38519$$

$$\phi_{sh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$\phi_{sh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 872.4558$$

$$fy_1 = 727.0465$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

```

lo/lou,min = lb/d = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 727.0465
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 882.7854
fy2 = 735.6545
su2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 735.6545
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 937.50
fyv = 781.25
suv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 781.25
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06860752
2 = Asl,com/(b*d)*(fs2/fc) = 0.12378842
v = Asl,mid/(b*d)*(fsv/fc) = 0.04175429
and confined core properties:
b = 340.00
d = 597.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.08477074
2 = Asl,com/(b*d)*(fs2/fc) = 0.15295169
v = Asl,mid/(b*d)*(fsv/fc) = 0.05159117
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.09460844
Mu = MRc (4.14) = 4.6479E+008
u = su (4.1) = 5.6369735E-005

```

Calculation of ratio lb/d

Adequate Lap Length: lb/d >= 1

Calculation of Mu1-

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

$$\mu = 6.0907698E-005$$

$$\mu_u = 7.8817E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.000307$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$\alpha (5A.5, \text{TB DY}) = 0.002$$

$$\text{Final value of } \mu_u: \mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, \alpha) = 0.0053097$$

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

$$\text{From (5.4b), TB DY: } \mu_u = 0.0053097$$

$$\mu_{ue} (5.4c) = 0.00204688$$

$$\alpha_{se} ((5.4d), \text{TB DY}) = (\alpha_{se1} * A_{ext} + \alpha_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$\alpha_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$\alpha_{se2} = \text{Max}(\alpha_{se1}, \alpha_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$\mu_{sh, \min} * F_{ywe} = \text{Min}(\mu_{sh, x} * F_{ywe}, \mu_{sh, y} * F_{ywe}) = 1.38519$$

Expression ((5.4d), TB DY) for $\mu_{sh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\mu_{sh, x} * F_{ywe} = \mu_{sh1} * F_{ywe1} + \mu_{sh2} * F_{ywe2} = 2.45559$$

$$\mu_{sh1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$\mu_{sh2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$\mu_{sh, y} * F_{ywe} = \mu_{sh1} * F_{ywe1} + \mu_{sh2} * F_{ywe2} = 1.38519$$

$$\mu_{sh1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$\mu_{sh2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TB DY), TB DY: } \alpha = 0.002$$

$$\alpha = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$s_{h1} = 0.008$$

$$f_{t1} = 882.7854$$


```

fy1 = 735.6545
su1 = 0.032
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb = 1.00
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 735.6545
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 872.4558
fy2 = 727.0465
su2 = 0.032
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 1.00
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 727.0465
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 937.50
fyv = 781.25
suv = 0.032
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb = 1.00
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 781.25
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.12378842
2 = Asl,com/(b*d)*(fs2/fc) = 0.06860752
v = Asl,mid/(b*d)*(fsv/fc) = 0.04175429
and confined core properties:
b = 340.00
d = 597.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.15295169
    2 = Asl,com/(b*d)*(fs2/fc) = 0.08477074
    v = Asl,mid/(b*d)*(fsv/fc) = 0.05159117
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
---->
v < vs,y2 - LHS eq.(4.5) is not satisfied
---->
v < vs,c - RHS eq.(4.5) is satisfied
---->
su (4.8) = 0.16206515

```

$$\begin{aligned} \mu &= M_{Rc} (4.15) = 7.8817E+008 \\ u &= s_u (4.1) = 6.0907698E-005 \end{aligned}$$

Calculation of ratio I_b/I_d

Adequate Lap Length: $I_b/I_d \geq 1$

Calculation of μ_{u2+}

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

$$\begin{aligned} u &= 5.6369735E-005 \\ \mu &= 4.6479E+008 \end{aligned}$$

with full section properties:

$$\begin{aligned} b &= 400.00 \\ d &= 627.00 \\ d' &= 43.00 \\ v &= 0.000307 \\ N &= 2309.833 \\ f_c &= 30.00 \\ c_o (5A.5, TBDY) &= 0.002 \\ \text{Final value of } c_u: c_u^* &= \text{shear_factor} * \text{Max}(c_u, c_c) = 0.0053097 \\ \text{The Shear_factor is considered equal to 1 (pure moment strength)} \\ \text{From (5.4b), TBDY: } c_u &= 0.0053097 \\ w_e (5.4c) &= 0.00204688 \\ a_{se} ((5.4d), TBDY) &= (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895 \\ a_{se1} &= 0.14776895 \\ b_{o_1} &= 340.00 \\ h_{o_1} &= 610.00 \\ b_{i2_1} &= 975400.00 \\ a_{se2} = \text{Max}(a_{se1}, a_{se2}) &= 0.14776895 \\ b_{o_2} &= 192.00 \\ h_{o_2} &= 492.00 \\ b_{i2_2} &= 557856.00 \end{aligned}$$

$p_{sh,min} * F_{ywe} = \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.38519$
 Expression ((5.4d), TBDY) for $p_{sh,min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\begin{aligned} p_{sh,x} * F_{ywe} &= p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.45559 \\ p_{s1} \text{ (external)} &= (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799 \\ A_{sh1} &= A_{stir_1} * n_{s_1} = 157.0796 \\ \text{No stirrups, } n_{s_1} &= 2.00 \\ h_1 &= 670.00 \\ p_{s2} \text{ (internal)} &= (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519 \\ A_{sh2} &= A_{stir_2} * n_{s_2} = 100.531 \\ \text{No stirrups, } n_{s_2} &= 2.00 \\ h_2 &= 500.00 \end{aligned}$$

$$\begin{aligned} p_{sh,y} * F_{ywe} &= p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.38519 \\ p_{s1} \text{ (external)} &= (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298 \\ A_{sh1} &= A_{stir_1} * n_{s_1} = 157.0796 \\ \text{No stirrups, } n_{s_1} &= 2.00 \\ h_1 &= 400.00 \\ p_{s2} \text{ (internal)} &= (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008 \\ A_{sh2} &= A_{stir_2} * n_{s_2} = 100.531 \\ \text{No stirrups, } n_{s_2} &= 2.00 \\ h_2 &= 200.00 \end{aligned}$$

$$\begin{aligned} A_{sec} &= 268000.00 \\ s_1 &= 150.00 \\ s_2 &= 300.00 \\ f_{ywe1} &= 781.25 \end{aligned}$$

```

fywe2 = 656.25
fce = 30.00
From ((5A.5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.0025
sh1 = 0.008
ft1 = 872.4558
fy1 = 727.0465
su1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 727.0465
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 882.7854
fy2 = 735.6545
su2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 735.6545
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 937.50
fyv = 781.25
suv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 781.25
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06860752
2 = Asl,com/(b*d)*(fs2/fc) = 0.12378842
v = Asl,mid/(b*d)*(fsv/fc) = 0.04175429
and confined core properties:
b = 340.00
d = 597.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.08477074
2 = Asl,com/(b*d)*(fs2/fc) = 0.15295169
v = Asl,mid/(b*d)*(fsv/fc) = 0.05159117
Case/Assumption: Unconfinedsd full section - Steel rupture

```

satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$s_u(4.9) = 0.09460844$

$\mu_u = M_{Rc}(4.14) = 4.6479E+008$

$u = s_u(4.1) = 5.6369735E-005$

Calculation of ratio I_b/I_d

Adequate Lap Length: $I_b/I_d \geq 1$

Calculation of μ_{u2} -

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

$u = 6.0907698E-005$

$\mu_u = 7.8817E+008$

with full section properties:

$b = 400.00$

$d = 627.00$

$d' = 43.00$

$v = 0.000307$

$N = 2309.833$

$f_c = 30.00$

$\phi_c(5A.5, \text{TBDY}) = 0.002$

Final value of ϕ_{cu} : $\phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_c) = 0.0053097$

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

From (5.4b), TBDY: $\phi_{cu} = 0.0053097$

$\phi_{we}(5.4c) = 0.00204688$

$\phi_{ase}((5.4d), \text{TBDY}) = (\phi_{ase1} * A_{ext} + \phi_{ase2} * A_{int}) / A_{sec} = 0.14776895$

$\phi_{ase1} = 0.14776895$

$b_{o_1} = 340.00$

$h_{o_1} = 610.00$

$b_{i2_1} = 975400.00$

$\phi_{ase2} = \text{Max}(\phi_{ase1}, \phi_{ase2}) = 0.14776895$

$b_{o_2} = 192.00$

$h_{o_2} = 492.00$

$b_{i2_2} = 557856.00$

$\phi_{psh,min} * F_{ywe} = \text{Min}(\phi_{psh,x} * F_{ywe}, \phi_{psh,y} * F_{ywe}) = 1.38519$

Expression ((5.4d), TBDY) for $\phi_{psh,min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$\phi_{psh,x} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{psh2} * F_{ywe2} = 2.45559$

$\phi_{ps1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$

$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$

No stirrups, $n_{s_1} = 2.00$

$h_1 = 670.00$

$\phi_{ps2}(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$

$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$

No stirrups, $n_{s_2} = 2.00$

$h_2 = 500.00$

$\phi_{psh,y} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{psh2} * F_{ywe2} = 1.38519$

$\phi_{ps1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$

$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$

No stirrups, $n_{s_1} = 2.00$

$h_1 = 400.00$

$\phi_{ps2}(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$

$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$

No stirrups, $n_{s_2} = 2.00$

$h_2 = 200.00$

```

Asec = 268000.00
s1 = 150.00
s2 = 300.00
fywe1 = 781.25
fywe2 = 656.25
fce = 30.00
From ((5.A.5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.0025
sh1 = 0.008
ft1 = 882.7854
fy1 = 735.6545
su1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 735.6545
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 872.4558
fy2 = 727.0465
su2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 727.0465
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 937.50
fyv = 781.25
suv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 781.25
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.12378842
2 = Asl,com/(b*d)*(fs2/fc) = 0.06860752
v = Asl,mid/(b*d)*(fsv/fc) = 0.04175429
and confined core properties:
b = 340.00
d = 597.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002

```

$c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.15295169$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.08477074$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.05159117$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y2}$ - LHS eq.(4.5) is not satisfied
 --->
 $v < v_{s,c}$ - RHS eq.(4.5) is satisfied
 --->
 $s_u(4.8) = 0.16206515$
 $M_u = M_{Rc}(4.15) = 7.8817E+008$
 $u = s_u(4.1) = 6.0907698E-005$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 578810.994$

Calculation of Shear Strength at edge 1, $V_{r1} = 578810.994$
 $V_{r1} = V_n((22.5.1.1), \text{ACI } 318-14)$

NOTE: In expression (22.5.1.1) 'V_w' is replaced by 'V_w + f*V_f'
 where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 192813.976$
 $= 1$ (normal-weight concrete)
 Mean concrete strength: $f'_c = (f'_{c_jacket} * \text{Area}_{jacket} + f'_{c_core} * \text{Area}_{core}) / \text{Area}_{section} = 27.76119$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $p_w = A_s/(b_w*d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 400.00$
 $d = 536.00$
 $V_u*d/M_u < 1 = 1.00$
 $M_u = 1.1510E+006$
 $V_u = 9840.634$
 From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 385997.017$
 $V_{s1} = 350811.18$ is calculated for jacket, with:
 $d = 536.00$
 $A_v = 157079.633$
 $f_y = 625.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 35185.838$ is calculated for jacket, with:
 $d_2 = 400.00$
 $A_v = 100530.965$
 $f_y = 525.00$
 $s = 300.00$
 V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
 $V_f((11-3)-(11.4), \text{ACI } 440) = 0.00$
 From (11-11), ACI 440: $V_s + V_f \leq 750430.726$

Calculation of Shear Strength at edge 2, $V_{r2} = 578810.994$
 $V_{r2} = V_n((22.5.1.1), \text{ACI } 318-14)$

NOTE: In expression (22.5.1.1) 'V_w' is replaced by 'V_w + f*V_f'
 where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 192813.976$
 $= 1$ (normal-weight concrete)

Mean concrete strength: $fc' = (fc'_{jacket} \cdot Area_{jacket} + fc'_{core} \cdot Area_{core}) / Area_{section} = 27.76119$, but $fc'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$pw = As / (bw \cdot d) = 0.00331157$

As (tension reinf.) = 709.9999

$bw = 400.00$

$d = 536.00$

$Vu \cdot d / Mu < 1 = 1.00$

$Mu = 1.1510E+006$

$Vu = 9840.632$

From (11.5.4.8), ACI 318-14: $Vs1 + Vs2 = 385997.017$

$Vs1 = 350811.18$ is calculated for jacket, with:

$d = 536.00$

$Av = 157079.633$

$fy = 625.00$

$s = 150.00$

$Vs1$ has been multiplied by 1 ($s < d/2$, according to ASCE 41-17, 10.3.4)

$Vs2 = 35185.838$ is calculated for jacket, with:

$d = 400.00$

$Av = 100530.965$

$fy = 525.00$

$s = 300.00$

$Vs2$ has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17, 10.3.4)

$2(1-s/d) = 0.50$

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

From (11-11), ACI 440: $Vs + Vf \leq 750430.726$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 2

(Bending local axis: 3)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\phi = 0.87$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $fc = f_{cm} = 30.00$

New material of Secondary Member: Steel Strength, $fs = f_{sm} = 625.00$

Concrete Elasticity, $Ec = 25742.96$

Steel Elasticity, $Es = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $fc = f_{cm} = 24.00$

Existing material of Secondary Member: Steel Strength, $fs = f_{sm} = 525.00$

Concrete Elasticity, $Ec = 23025.204$

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, $fs = 1.25 \cdot f_{sm} = 781.25$

Existing Column

Existing material: Steel Strength, $fs = 1.25 \cdot f_{sm} = 656.25$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length, $L = 3000.00$

Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length ($l_o/l_{ou}, \min \geq 1$)
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, $V_a = -9.0372119E-015$
EDGE -B-
Shear Force, $V_b = 9.0372119E-015$
BOTH EDGES
Axial Force, $F = -2309.833$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $As_t = 709.9999$
-Compression: $As_c = 1668.186$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $As_{t,ten} = 911.0619$
-Compression: $As_{c,com} = 911.0619$
-Middle: $As_{l,mid} = 556.0619$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.55914272$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 218168.257$
with
 $M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 3.2725E+008$
 $\mu_{u1+} = 3.2725E+008$, 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
 $\mu_{u1-} = 3.2725E+008$, 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
 $M_{pr2} = \max(\mu_{u2+}, \mu_{u2-}) = 3.2725E+008$
 $\mu_{u2+} = 3.2725E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the static loading combination
 $\mu_{u2-} = 3.2725E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination
and
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$
with
 $V_1 = -9.0372119E-015$, is the shear force acting at edge 1 for the static loading combination
 $V_2 = 9.0372119E-015$, is the shear force acting at edge 2 for the static loading combination

Calculation of μ_{u1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 0.00010507$
 $\mu_u = 3.2725E+008$

with full section properties:

$b = 670.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.0003219$
 $N = 2309.833$
 $f_c = 30.00$
 $\alpha (5A.5, TBDY) = 0.002$
Final value of ϕ_u : $\phi_u^* = \text{shear_factor} \cdot \max(\phi_u, \phi_c) = 0.0053097$

The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $c_u = 0.0053097$
 w_e (5.4c) = 0.00204688
 a_{se} ((5.4d), TBDY) = $(a_{se1} \cdot A_{ext} + a_{se2} \cdot A_{int}) / A_{sec} = 0.14776895$
 $a_{se1} = 0.14776895$
 $b_{o_1} = 340.00$
 $h_{o_1} = 610.00$
 $b_{i2_1} = 975400.00$
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$
 $b_{o_2} = 192.00$
 $h_{o_2} = 492.00$
 $b_{i2_2} = 557856.00$
 $p_{sh, \min} \cdot F_{ywe} = \text{Min}(p_{sh, x} \cdot F_{ywe}, p_{sh, y} \cdot F_{ywe}) = 1.38519$
 Expression ((5.4d), TBDY) for $p_{sh, \min} \cdot F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh, x} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{s2} \cdot F_{ywe2} = 2.45559$
 p_{s1} (external) = $(A_{sh1} \cdot h_1 / s_1) / A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir_1} \cdot n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h_1 = 670.00$
 p_{s2} (internal) = $(A_{sh2} \cdot h_2 / s_2) / A_{sec} = 0.00062519$
 $A_{sh2} = A_{stir_2} \cdot n_{s_2} = 100.531$
 No stirrups, $n_{s_2} = 2.00$
 $h_2 = 500.00$

$p_{sh, y} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{s2} \cdot F_{ywe2} = 1.38519$
 p_{s1} (external) = $(A_{sh1} \cdot h_1 / s_1) / A_{sec} = 0.00156298$
 $A_{sh1} = A_{stir_1} \cdot n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h_1 = 400.00$
 p_{s2} (internal) = $(A_{sh2} \cdot h_2 / s_2) / A_{sec} = 0.00025008$
 $A_{sh2} = A_{stir_2} \cdot n_{s_2} = 100.531$
 No stirrups, $n_{s_2} = 2.00$
 $h_2 = 200.00$

$A_{sec} = 268000.00$
 $s_1 = 150.00$
 $s_2 = 300.00$
 $f_{ywe1} = 781.25$
 $f_{ywe2} = 656.25$
 $f_{ce} = 30.00$

From ((5.A5), TBDY), TBDY: $c_c = 0.002$
 c = confinement factor = 1.00

$y_1 = 0.0025$
 $sh_1 = 0.008$
 $ft_1 = 886.8103$
 $fy_1 = 739.0086$
 $su_1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

$l_o / l_{ou, \min} = l_b / l_d = 1.00$

$su_1 = 0.4 \cdot esu_{1_nominal}$ ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: $esu_{1_nominal} = 0.08$,

For calculation of $esu_{1_nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered
 characteristic value $fsy_1 = fs_1 / 1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b / l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs_1 = (f_{s, \text{jacket}} \cdot A_{s, \text{ten, jacket}} + f_{s, \text{core}} \cdot A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 739.0086$

with $Es_1 = (E_{s, \text{jacket}} \cdot A_{s, \text{ten, jacket}} + E_{s, \text{core}} \cdot A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 200000.00$

$y_2 = 0.0025$
 $sh_2 = 0.008$
 $ft_2 = 886.8103$
 $fy_2 = 739.0086$
 $su_2 = 0.032$

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

```

Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 739.0086
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 895.9746
fyv = 746.6455
suv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 746.6455
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09382814
2 = Asl,com/(b*d)*(fs2/fc) = 0.09382814
v = Asl,mid/(b*d)*(fsv/fc) = 0.05785932
and confined core properties:
b = 610.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11251192
2 = Asl,com/(b*d)*(fs2/fc) = 0.11251192
v = Asl,mid/(b*d)*(fsv/fc) = 0.06938071
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.9) = 0.1468828
Mu = MRc (4.14) = 3.2725E+008
u = su (4.1) = 0.00010507

```

Calculation of ratio lb/d

Adequate Lap Length: lb/d >= 1

Calculation of Mu1-

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

u = 0.00010507
Mu = 3.2725E+008

with full section properties:

b = 670.00
d = 357.00
d' = 43.00

$v = 0.0003219$
 $N = 2309.833$
 $f_c = 30.00$
 $\alpha (5A.5, \text{TB DY}) = 0.002$
 Final value of α : $\alpha = \text{shear_factor} * \text{Max}(\alpha_c, \alpha) = 0.0053097$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TB DY: $\alpha = 0.0053097$
 $w_e (5.4c) = 0.00204688$
 $\alpha_e ((5.4d), \text{TB DY}) = (\alpha_1 * A_{ext} + \alpha_2 * A_{int}) / A_{sec} = 0.14776895$
 $\alpha_1 = 0.14776895$
 $b_{o1} = 340.00$
 $h_{o1} = 610.00$
 $b_{i21} = 975400.00$
 $\alpha_2 = \text{Max}(\alpha_1, \alpha_2) = 0.14776895$
 $b_{o2} = 192.00$
 $h_{o2} = 492.00$
 $b_{i22} = 557856.00$
 $\phi_{sh, \min} * F_{ywe} = \text{Min}(\phi_{sh, x} * F_{ywe}, \phi_{sh, y} * F_{ywe}) = 1.38519$
 Expression ((5.4d), TB DY) for $\phi_{sh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$\phi_{sh, x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.45559$
 $\phi_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h_1 = 670.00$
 $\phi_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirrups, $n_{s_2} = 2.00$
 $h_2 = 500.00$

$\phi_{sh, y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.38519$
 $\phi_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h_1 = 400.00$
 $\phi_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirrups, $n_{s_2} = 2.00$
 $h_2 = 200.00$

$A_{sec} = 268000.00$
 $s_1 = 150.00$
 $s_2 = 300.00$

$f_{ywe1} = 781.25$
 $f_{ywe2} = 656.25$
 $f_{ce} = 30.00$

From ((5.A5), TB DY), TB DY: $\alpha_c = 0.002$
 $\alpha_c = \text{confinement factor} = 1.00$

$y_1 = 0.0025$
 $sh_1 = 0.008$
 $ft_1 = 886.8103$
 $fy_1 = 739.0086$
 $su_1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

$l_o / l_{ou, \min} = l_b / l_d = 1.00$

$su_1 = 0.4 * esu_{1, \text{nominal}} ((5.5), \text{TB DY}) = 0.032$

From table 5A.1, TB DY: $esu_{1, \text{nominal}} = 0.08$,

For calculation of $esu_{1, \text{nominal}}$ and y_1, sh_1, ft_1, fy_1 , it is considered
 characteristic value $fs_1 = fs_1 / 1.2$, from table 5.1, TB DY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b / l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs_1 = (f_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + f_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 739.0086$

with $Es_1 = (E_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + E_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 200000.00$

$y_2 = 0.0025$
 $sh_2 = 0.008$

```

ft2 = 886.8103
fy2 = 739.0086
su2 = 0.032
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/lb,min = 1.00
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 739.0086
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
    yv = 0.0025
    shv = 0.008
ftv = 895.9746
fyv = 746.6455
suv = 0.032
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/ld = 1.00
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 746.6455
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.09382814
    2 = Asl,com/(b*d)*(fs2/fc) = 0.09382814
    v = Asl,mid/(b*d)*(fsv/fc) = 0.05785932
and confined core properties:
b = 610.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.11251192
    2 = Asl,com/(b*d)*(fs2/fc) = 0.11251192
    v = Asl,mid/(b*d)*(fsv/fc) = 0.06938071
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)
---->
v < vs,c - RHS eq.(4.5) is satisfied
---->
su (4.9) = 0.1468828
Mu = MRc (4.14) = 3.2725E+008
u = su (4.1) = 0.00010507

```

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

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

u = 0.00010507
Mu = 3.2725E+008

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.0003219$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$\alpha (5A.5, \text{TB DY}) = 0.002$$

$$\text{Final value of } \alpha: \alpha^* = \text{shear_factor} * \text{Max}(\alpha, \alpha_c) = 0.0053097$$

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

$$\text{From (5.4b), TB DY: } \alpha_c = 0.0053097$$

$$\alpha_w (5.4c) = 0.00204688$$

$$\alpha_{se} ((5.4d), \text{TB DY}) = (\alpha_{se1} * A_{ext} + \alpha_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$\alpha_{se1} = 0.14776895$$

$$b_{o1} = 340.00$$

$$h_{o1} = 610.00$$

$$b_{i21} = 975400.00$$

$$\alpha_{se2} = \text{Max}(\alpha_{se1}, \alpha_{se2}) = 0.14776895$$

$$b_{o2} = 192.00$$

$$h_{o2} = 492.00$$

$$b_{i22} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.38519$$

Expression ((5.4d), TB DY) for $p_{sh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.45559$$

$$p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir, 1} * n_{s, 1} = 157.0796$$

$$\text{No stirrups, } n_{s, 1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir, 2} * n_{s, 2} = 100.531$$

$$\text{No stirrups, } n_{s, 2} = 2.00$$

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.38519$$

$$p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir, 1} * n_{s, 1} = 157.0796$$

$$\text{No stirrups, } n_{s, 1} = 2.00$$

$$h_1 = 400.00$$

$$p_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir, 2} * n_{s, 2} = 100.531$$

$$\text{No stirrups, } n_{s, 2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TB DY), TB DY: } \alpha_c = 0.002$$

$$\alpha_c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 886.8103$$

$$fy_1 = 739.0086$$

$$su_1 = 0.032$$

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

and also multiplied by the shear_factor according to 15.7.1.4, with

$$\text{Shear_factor} = 1.00$$

$$l_o / l_{ou, \min} = l_b / l_d = 1.00$$

$$su_1 = 0.4 * esu_1_{\text{nominal}} ((5.5), \text{TB DY}) = 0.032$$

From table 5A.1, TB DY: $esu_1_{\text{nominal}} = 0.08$,

For calculation of esu_1_{nominal} and y_1 , sh_1 , ft_1 , fy_1 , it is considered characteristic value $fsy_1 = fs_1 / 1.2$, from table 5.1, TB DY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs1 = (fs_{jacket} \cdot Asl_{ten,jacket} + fs_{core} \cdot Asl_{ten,core}) / Asl_{ten} = 739.0086$
 with $Es1 = (Es_{jacket} \cdot Asl_{ten,jacket} + Es_{core} \cdot Asl_{ten,core}) / Asl_{ten} = 200000.00$
 $y2 = 0.0025$
 $sh2 = 0.008$
 $ft2 = 886.8103$
 $fy2 = 739.0086$
 $su2 = 0.032$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lo_{u,min} = lb/lb_{min} = 1.00$
 $su2 = 0.4 \cdot esu2_{nominal} ((5.5), \text{TBDY}) = 0.032$
 From table 5A.1, TBDY: $esu2_{nominal} = 0.08$,
 For calculation of $esu2_{nominal}$ and $y2, sh2, ft2, fy2$, it is considered
 characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs2 = (fs_{jacket} \cdot Asl_{com,jacket} + fs_{core} \cdot Asl_{com,core}) / Asl_{com} = 739.0086$
 with $Es2 = (Es_{jacket} \cdot Asl_{com,jacket} + Es_{core} \cdot Asl_{com,core}) / Asl_{com} = 200000.00$
 $yv = 0.0025$
 $shv = 0.008$
 $ftv = 895.9746$
 $fyv = 746.6455$
 $suv = 0.032$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lo_{u,min} = lb/ld = 1.00$
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), \text{TBDY}) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and yv, shv, ftv, fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs_{jacket} \cdot Asl_{mid,jacket} + fs_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 746.6455$
 with $Es_v = (Es_{jacket} \cdot Asl_{mid,jacket} + Es_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 200000.00$
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.09382814$
 $2 = Asl_{com} / (b \cdot d) \cdot (fs2 / fc) = 0.09382814$
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.05785932$
 and confined core properties:
 $b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $fcc (5A.2, \text{TBDY}) = 30.00$
 $cc (5A.5, \text{TBDY}) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.11251192$
 $2 = Asl_{com} / (b \cdot d) \cdot (fs2 / fc) = 0.11251192$
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.06938071$
 Case/Assumption: Unconfined full section - Steel rupture
 ' does not satisfy Eq. (4.3)
 --->
 $v < v_{s,c}$ - RHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.1468828$
 $Mu = MRc (4.14) = 3.2725E+008$
 $u = su (4.1) = 0.00010507$

 Calculation of ratio lb/ld

Adequate Lap Length: $lb/ld \geq 1$

Calculation of $Mu2$ -

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

$$u = 0.00010507$$

$$\mu = 3.2725E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.0003219$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$\alpha (5A.5, \text{TBDY}) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.0053097$$

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

$$\text{From (5.4b), TBDY: } \phi_u = 0.0053097$$

$$\phi_{ue} \text{ (5.4c)} = 0.00204688$$

$$\phi_{se} \text{ ((5.4d), TBDY)} = (\phi_{se1} * A_{ext} + \phi_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$\phi_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$\phi_{se2} = \text{Max}(\phi_{se1}, \phi_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$\phi_{sh,min} * F_{ywe} = \text{Min}(\phi_{sh,x} * F_{ywe}, \phi_{sh,y} * F_{ywe}) = 1.38519$$

Expression ((5.4d), TBDY) for $\phi_{sh,min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\phi_{sh,x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.45559$$

$$\phi_{sh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$\phi_{sh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$\phi_{sh,y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.38519$$

$$\phi_{sh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$\phi_{sh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 886.8103$$

$$fy_1 = 739.0086$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

```

lo/lou,min = lb/d = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 739.0086
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 886.8103
fy2 = 739.0086
su2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 739.0086
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 895.9746
fyv = 746.6455
suv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 746.6455
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09382814
2 = Asl,com/(b*d)*(fs2/fc) = 0.09382814
v = Asl,mid/(b*d)*(fsv/fc) = 0.05785932
and confined core properties:
b = 610.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11251192
2 = Asl,com/(b*d)*(fs2/fc) = 0.11251192
v = Asl,mid/(b*d)*(fsv/fc) = 0.06938071
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.9) = 0.1468828
Mu = MRc (4.14) = 3.2725E+008
u = su (4.1) = 0.00010507

```

Calculation of ratio lb/d

Adequate Lap Length: lb/d >= 1

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 390183.487$

Calculation of Shear Strength at edge 1, $V_{r1} = 390183.487$
 $V_{r1} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 180743.977$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot \text{Area}_{jacket} + f'_{c_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 27.76119$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $p_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 670.00$
 $d = 320.00$
 $V_u \cdot d / \mu < 1 = 0.00$
 $\mu = 6.8565666E-012$
 $V_u = 9.0372119E-015$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 209439.51$
 $V_{s1} = 209439.51$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 625.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 0.00$ is calculated for jacket, with:
 $d_2 = 160.00$
 $A_v = 100530.965$
 $f_y = 525.00$
 $s = 300.00$
 V_{s2} is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)
 V_f ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f \leq 750430.726$

Calculation of Shear Strength at edge 2, $V_{r2} = 390183.487$
 $V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 180743.977$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot \text{Area}_{jacket} + f'_{c_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 27.76119$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $p_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 670.00$
 $d = 320.00$
 $V_u \cdot d / \mu < 1 = 0.00$
 $\mu = 2.0256286E-011$
 $V_u = 9.0372119E-015$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 209439.51$
 $V_{s1} = 209439.51$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 625.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 0.00$ is calculated for jacket, with:
 $d = 160.00$
 $A_v = 100530.965$
 $f_y = 525.00$

$s = 300.00$

V_{s2} is considered 0 ($s > d$, according to ASCE 41-17, 10.3.4)

$V_f((11-3)-(11.4), \text{ACI 440}) = 0.00$

From (11-11), ACI 440: $V_s + V_f \leq 750430.726$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\phi = 0.87$

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, $f_c = f_{cm} = 30.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_b/d \geq 1$)

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 9.0425E+006$

Shear Force, $V_2 = 2.4489115E-014$

Shear Force, $V_3 = 1166.41$

Axial Force, $F = -9608.729$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 709.9999$

-Compression: $As_c = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten} = 709.9999$

-Compression: $As_{l,com} = 1266.062$

-Middle: $As_{l,mid} = 402.1239$

Longitudinal External Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{l,ten,jacket} = 402.1239$

-Compression: $As_{l,com,jacket} = 804.2477$

-Middle: $As_{l,mid,jacket} = 402.1239$

Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{l,ten,core} = 307.8761$

-Compression: $As_{l,com,core} = 461.8141$

-Middle: $Asl_{mid,core} = 0.00$

Mean Diameter of Tension Reinforcement, $DbL = 15.00$

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = u = 0.02848337$
 $u = y + p = 0.0327395$

- Calculation of y -

$y = (My * Ls / 3) / E_{eff} = 0.0077395$ ((4.29), Biskinis Phd))
 $My = 2.9297E+008$
 $Ls = M/V$ (with $Ls > 0.1 * L$ and $Ls < 2 * L$) = 6000.00
From table 10.5, ASCE 41_17: $E_{eff} = 0.3 * E_c * I_g = 7.5708E+013$

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7 -

$y = \min(y_{ten}, y_{com})$
 $y_{ten} = 5.8262953E-006$
with $f_y = 625.00$
 $d = 627.00$
 $y = 0.18885675$
 $A = 0.00954705$
 $B = 0.00409845$
with $p_t = 0.00283094$
 $p_c = 0.00504809$
 $p_v = 0.00160336$
 $N = 9608.729$
 $b = 400.00$
 $" = 0.06858054$
 $y_{comp} = 1.7813453E-005$
with $f_c = 27.76119$
 $E_c = 25742.96$
 $y = 0.18781039$
 $A = 0.00939108$
 $B = 0.0040338$
with $E_s = 200000.00$

Calculation of ratio l_b/d

Adequate Lap Length: $l_b/d \geq 1$

- Calculation of p -

From table 10-7: $p = 0.025$

with:

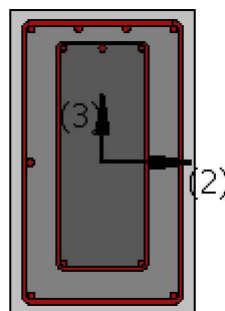
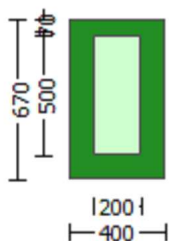
- Condition i occurred
Beam controlled by flexure: $V_p/V_o \leq 1$
shear control ratio $V_p/V_o = 0.92480584$
- Transverse Reinforcement: C
- Stirrup Spacing $\leq d/3$
- Low ductility demand, $y < 2$ (table 10-6, ASCE 41-17)
 $= 7.8771085E-005$
- Stirrup Spacing $\leq d/2$
 $d = d_{external} = 627.00$
 $s = s_{external} = 150.00$
- Strength provided by hoops $V_s < 3/4 * \text{design Shear}$
 $V_s = 421182.855$, already given in calculation of shear control ratio
design Shear = 1166.41

$\rho = \rho' / \rho_{bal} = -0.3178459$
 $\rho = A_{st} / (b_w \cdot d) = 0.00283094$
 Tension Reinf Area: $A_{st} = 709.9999$
 $\rho' = A_{sc} / (b_w \cdot d) = 0.00665146$
 Compression Reinf Area: $A_{sc} = 1668.186$
 From (B-1), ACI 318-11: $\rho_{bal} = 0.01202003$
 $f_c = (f_{c_jacket} \cdot Area_jacket + f_{c_core} \cdot Area_core) / section_area = 27.76119$
 $f_y = f_{y_jacket_bars} = 625.00$
 From 10.2.7.3, ACI 318-11: $\lambda = 0.65$
 From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000 / (87000 + f_y) = c_b / d_t = 0.003 / (0.003 + \lambda \cdot y) = 0.48979592$
 $y = 0.003125$
 $V / (b_w \cdot d \cdot f_c^{0.5}) = 0.01062987$, NOTE: units in lb & in
 $b_w = 400.00$

 End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1
 At local axis: 2
 Integration Section: (a)

Calculation No. 11

beam B1, Floor 1
 Limit State: Life Safety (data interpolation between analysis steps 1 and 2)
 Analysis: Uniform +X
 Check: Shear capacity V_{Rd}
 Edge: Start
 Local Axis: (3)



Start Of Calculation of Shear Capacity for element: beam JB1 of floor 1
 At local axis: 3
 Integration Section: (a)
 Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 0.87$

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, $f_c = f_{c_lower_bound} = 20.00$
 New material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$
 Concrete Elasticity, $E_c = 25742.96$
 Steel Elasticity, $E_s = 200000.00$
 Existing Column
 Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$
 Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 420.00$
 Concrete Elasticity, $E_c = 23025.204$
 Steel Elasticity, $E_s = 200000.00$
 External Height, $H = 670.00$
 External Width, $W = 400.00$
 Internal Height, $H = 500.00$
 Internal Width, $W = 200.00$
 Cover Thickness, $c = 25.00$
 Element Length, $L = 3000.00$
 Secondary Member
 Smooth Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Adequate Lap Length ($l_o/l_{ou,min} = l_b/l_d \geq 1$)
 No FRP Wrapping

Stepwise Properties

EDGE -A-
 Bending Moment, $M_a = 9.0425E+006$
 Shear Force, $V_a = 1166.41$
 EDGE -B-
 Bending Moment, $M_b = 1.6981E+007$
 Shear Force, $V_b = 18514.856$
 BOTH EDGES
 Axial Force, $F = -9608.729$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $As_t = 709.9999$
 -Compression: $As_c = 1668.186$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten} = 709.9999$
 -Compression: $As_{l,com} = 1266.062$
 -Middle: $As_{l,mid} = 402.1239$
 Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 15.00$

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = V_n = 397771.806$
 V_n ((22.5.1.1), ACI 318-14) = 457208.973

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f^*V_f$ '
 where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 148411.359$
 = 1 (normal-weight concrete)
 Mean concrete strength: $f'_c = (f'_c_jacket * Area_jacket + f'_c_core * Area_core) / Area_section = 18.50746$, but $f_c^{0.5} < 8.3$ MPa (22.5.3.1, ACI 318-14)
 $p_w = A_s / (b_w * d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 400.00$
 $d = 536.00$
 $V_u * d / M_u < 1 = 0.06913998$
 $M_u = 9.0425E+006$
 $V_u = 1166.41$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 308797.614$

$V_{s1} = 280648.944$ is calculated for jacket, with:

$d = 536.00$

$A_v = 157079.633$

$f_y = 500.00$

$s = 150.00$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 28148.67$ is calculated for core, with:

$d = 400.00$

$A_v = 100530.965$

$f_y = 420.00$

$s = 300.00$

V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.50$

$V_f ((11-3)-(11.4), \text{ACI } 440) = 0.00$

From (11-11), ACI 440: $V_s + V_f \leq 612724.122$

End Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (a)

Calculation No. 12

beam B1, Floor 1

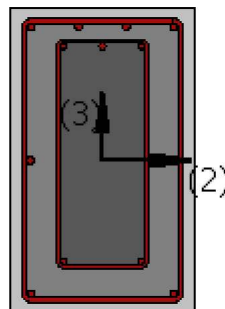
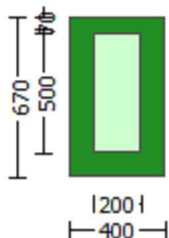
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (μ)

Edge: Start

Local Axis: (3)



Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\phi = 0.87$
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 30.00$
New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$
Concrete Elasticity, $E_c = 25742.96$
Steel Elasticity, $E_s = 200000.00$
Existing Column
Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$
Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$
Concrete Elasticity, $E_c = 23025.204$
Steel Elasticity, $E_s = 200000.00$

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, $f_s = 1.25 \cdot f_{sm} = 781.25$
Existing Column
Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 656.25$

External Height, $H = 670.00$
External Width, $W = 400.00$
Internal Height, $H = 500.00$
Internal Width, $W = 200.00$
Cover Thickness, $c = 25.00$
Mean Confinement Factor overall section = 1.00
Element Length, $L = 3000.00$
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length ($l_o/l_{ou,min} \geq 1$)
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, $V_a = 9840.634$
EDGE -B-
Shear Force, $V_b = 9840.632$
BOTH EDGES
Axial Force, $F = -2309.833$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{sl,t} = 709.9999$
-Compression: $A_{sl,c} = 1668.186$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{sl,ten} = 709.9999$
-Compression: $A_{sl,com} = 1266.062$
-Middle: $A_{sl,mid} = 402.1239$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.92480584$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 535287.788$
with
 $M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 7.8817E+008$
 $M_{u1+} = 4.6479E+008$, 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
 $M_{u1-} = 7.8817E+008$, 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
 $M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 7.8817E+008$

$Mu_{2+} = 4.6479E+008$, 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

$Mu_{2-} = 7.8817E+008$, 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
and

$$\pm wu*ln = (|V1| + |V2|)/2$$

with

$V1 = 9840.634$, is the shear force acting at edge 1 for the the static loading combination

$V2 = 9840.632$, is the shear force acting at edge 2 for the the static loading combination

Calculation of Mu_{1+}

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

$$u = 5.6369735E-005$$

$$Mu = 4.6479E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.000307$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$co(5A.5, TBDY) = 0.002$$

$$\text{Final value of } cu: cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0053097$$

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

$$\text{From (5.4b), TBDY: } cu = 0.0053097$$

$$we(5.4c) = 0.00204688$$

$$ase((5.4d), TBDY) = (ase1*Aext + ase2*Aint)/Asec = 0.14776895$$

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

$$ho_1 = 610.00$$

$$bi2_1 = 975400.00$$

$$ase2 = \text{Max}(ase1, ase2) = 0.14776895$$

$$bo_2 = 192.00$$

$$ho_2 = 492.00$$

$$bi2_2 = 557856.00$$

$$psh, \min * Fywe = \text{Min}(psh, x * Fywe, psh, y * Fywe) = 1.38519$$

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

$$psh, x * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 2.45559$$

$$ps1(\text{external}) = (Ash1 * h1 / s1) / Asec = 0.00261799$$

$$Ash1 = Astir_1 * ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h1 = 670.00$$

$$ps2(\text{internal}) = (Ash2 * h2 / s2) / Asec = 0.00062519$$

$$Ash2 = Astir_2 * ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h2 = 500.00$$

$$psh, y * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 1.38519$$

$$ps1(\text{external}) = (Ash1 * h1 / s1) / Asec = 0.00156298$$

$$Ash1 = Astir_1 * ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h1 = 400.00$$

$$ps2(\text{internal}) = (Ash2 * h2 / s2) / Asec = 0.00025008$$

$$Ash2 = Astir_2 * ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$


```

fywe1 = 781.25
fywe2 = 656.25
fce = 30.00
From ((5A.5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.0025
sh1 = 0.008
ft1 = 872.4558
fy1 = 727.0465
su1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 727.0465
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 882.7854
fy2 = 735.6545
su2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 735.6545
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 937.50
fyv = 781.25
suv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 781.25
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06860752
2 = Asl,com/(b*d)*(fs2/fc) = 0.12378842
v = Asl,mid/(b*d)*(fsv/fc) = 0.04175429
and confined core properties:
b = 340.00
d = 597.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.08477074
2 = Asl,com/(b*d)*(fs2/fc) = 0.15295169
v = Asl,mid/(b*d)*(fsv/fc) = 0.05159117

```

Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

μ_u (4.9) = 0.09460844

$M_u = M_{Rc}$ (4.14) = 4.6479E+008

$u = \mu_u$ (4.1) = 5.6369735E-005

Calculation of ratio I_b/I_d

Adequate Lap Length: $I_b/I_d \geq 1$

Calculation of μ_{u1} -

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

$\mu_u = 6.0907698E-005$

$M_u = 7.8817E+008$

with full section properties:

$b = 400.00$

$d = 627.00$

$d' = 43.00$

$v = 0.000307$

$N = 2309.833$

$f_c = 30.00$

α (5A.5, TBDY) = 0.002

Final value of μ_{cu} : $\mu_{cu}^* = \text{shear_factor} * \text{Max}(\mu_{cu}, \mu_{cc}) = 0.0053097$

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

From (5.4b), TBDY: $\mu_{cu} = 0.0053097$

μ_{we} (5.4c) = 0.00204688

α_{se} ((5.4d), TBDY) = $(\alpha_{se1} * A_{ext} + \alpha_{se2} * A_{int}) / A_{sec} = 0.14776895$

$\alpha_{se1} = 0.14776895$

$b_{o,1} = 340.00$

$h_{o,1} = 610.00$

$b_{i2,1} = 975400.00$

$\alpha_{se2} = \text{Max}(\alpha_{se1}, \alpha_{se2}) = 0.14776895$

$b_{o,2} = 192.00$

$h_{o,2} = 492.00$

$b_{i2,2} = 557856.00$

$\mu_{psh,min} * F_{ywe} = \text{Min}(\mu_{psh,x} * F_{ywe}, \mu_{psh,y} * F_{ywe}) = 1.38519$

Expression ((5.4d), TBDY) for $\mu_{psh,min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$\mu_{psh,x} * F_{ywe} = \mu_{psh1} * F_{ywe1} + \mu_{psh2} * F_{ywe2} = 2.45559$

μ_{ps1} (external) = $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$

$A_{sh1} = A_{stir,1} * n_{s,1} = 157.0796$

No stirrups, $n_{s,1} = 2.00$

$h_1 = 670.00$

μ_{ps2} (internal) = $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$

$A_{sh2} = A_{stir,2} * n_{s,2} = 100.531$

No stirrups, $n_{s,2} = 2.00$

$h_2 = 500.00$

$\mu_{psh,y} * F_{ywe} = \mu_{psh1} * F_{ywe1} + \mu_{psh2} * F_{ywe2} = 1.38519$

μ_{ps1} (external) = $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$

$A_{sh1} = A_{stir,1} * n_{s,1} = 157.0796$

No stirrups, $n_{s,1} = 2.00$

$h_1 = 400.00$

μ_{ps2} (internal) = $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$

$A_{sh2} = A_{stir,2} * n_{s,2} = 100.531$

No stirrups, $n_{s,2} = 2.00$

$$h2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

$$\text{From } ((5.5), \text{TBDY}), \text{TBDY: } c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 882.7854$$

$$fy1 = 735.6545$$

$$su1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/ld = 1.00$$

$$su1 = 0.4 * esu1_{nominal} ((5.5), \text{TBDY}) = 0.032$$

$$\text{From table 5A.1, TBDY: } esu1_{nominal} = 0.08,$$

For calculation of $esu1_{nominal}$ and $y1, sh1, ft1, fy1$, it is considered
characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.

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

$$\text{with } fs1 = (fs_{jacket} * Asl, \text{ten}, \text{jacket} + fs_{core} * Asl, \text{ten}, \text{core}) / Asl, \text{ten} = 735.6545$$

$$\text{with } Es1 = (Es_{jacket} * Asl, \text{ten}, \text{jacket} + Es_{core} * Asl, \text{ten}, \text{core}) / Asl, \text{ten} = 200000.00$$

$$y2 = 0.0025$$

$$sh2 = 0.008$$

$$ft2 = 872.4558$$

$$fy2 = 727.0465$$

$$su2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/lb, \min = 1.00$$

$$su2 = 0.4 * esu2_{nominal} ((5.5), \text{TBDY}) = 0.032$$

$$\text{From table 5A.1, TBDY: } esu2_{nominal} = 0.08,$$

For calculation of $esu2_{nominal}$ and $y2, sh2, ft2, fy2$, it is considered
characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.

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

$$\text{with } fs2 = (fs_{jacket} * Asl, \text{com}, \text{jacket} + fs_{core} * Asl, \text{com}, \text{core}) / Asl, \text{com} = 727.0465$$

$$\text{with } Es2 = (Es_{jacket} * Asl, \text{com}, \text{jacket} + Es_{core} * Asl, \text{com}, \text{core}) / Asl, \text{com} = 200000.00$$

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 937.50$$

$$fyv = 781.25$$

$$suv = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/ld = 1.00$$

$$suv = 0.4 * esuv_{nominal} ((5.5), \text{TBDY}) = 0.032$$

$$\text{From table 5A.1, TBDY: } esuv_{nominal} = 0.08,$$

considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
For calculation of $esuv_{nominal}$ and yv, shv, ftv, fyv , it is considered
characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.

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

$$\text{with } fsv = (fs_{jacket} * Asl, \text{mid}, \text{jacket} + fs_{mid} * Asl, \text{mid}, \text{core}) / Asl, \text{mid} = 781.25$$

$$\text{with } Esv = (Es_{jacket} * Asl, \text{mid}, \text{jacket} + Es_{mid} * Asl, \text{mid}, \text{core}) / Asl, \text{mid} = 200000.00$$

$$1 = Asl, \text{ten} / (b * d) * (fs1 / f_c) = 0.12378842$$

$$2 = Asl, \text{com} / (b * d) * (fs2 / f_c) = 0.06860752$$

$$v = Asl, \text{mid} / (b * d) * (fsv / f_c) = 0.04175429$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc (5A.2, \text{TBDY}) = 30.00$$

```

cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.15295169
2 = Asl,com/(b*d)*(fs2/fc) = 0.08477074
v = Asl,mid/(b*d)*(fsv/fc) = 0.05159117
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.8) = 0.16206515
Mu = MRc (4.15) = 7.8817E+008
u = su (4.1) = 6.0907698E-005

```

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

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

```

u = 5.6369735E-005
Mu = 4.6479E+008

```

with full section properties:

```

b = 400.00
d = 627.00
d' = 43.00
v = 0.000307
N = 2309.833
fc = 30.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.0053097
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0053097
we (5.4c) = 0.00204688
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.14776895
ase1 = 0.14776895
bo_1 = 340.00
ho_1 = 610.00
bi2_1 = 975400.00
ase2 = Max(ase1,ase2) = 0.14776895
bo_2 = 192.00
ho_2 = 492.00
bi2_2 = 557856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.38519
Expression ((5.4d), TBDY) for psh,min*Fywe has been multiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

```

```

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.45559
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 500.00

```

```

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.38519

```

$$ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00156298$$

$$Ash1 = Astir_1 \cdot ns_1 = 157.0796$$

$$\text{No stirups, } ns_1 = 2.00$$

$$h1 = 400.00$$

$$ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00025008$$

$$Ash2 = Astir_2 \cdot ns_2 = 100.531$$

$$\text{No stirups, } ns_2 = 2.00$$

$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 781.25$$

$$fywe2 = 656.25$$

$$fce = 30.00$$

$$\text{From } ((5A5), \text{TB DY}), \text{TB DY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 872.4558$$

$$fy1 = 727.0465$$

$$su1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/ld = 1.00$$

$$su1 = 0.4 \cdot esu1_nominal \text{ ((5.5), TB DY)} = 0.032$$

$$\text{From table 5A.1, TB DY: } esu1_nominal = 0.08,$$

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

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

$$\text{with } fs1 = (fs_jacket \cdot Asl, \text{ten, jacket} + fs_core \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 727.0465$$

$$\text{with } Es1 = (Es_jacket \cdot Asl, \text{ten, jacket} + Es_core \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$$

$$y2 = 0.0025$$

$$sh2 = 0.008$$

$$ft2 = 882.7854$$

$$fy2 = 735.6545$$

$$su2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/lb, \min = 1.00$$

$$su2 = 0.4 \cdot esu2_nominal \text{ ((5.5), TB DY)} = 0.032$$

$$\text{From table 5A.1, TB DY: } esu2_nominal = 0.08,$$

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

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

$$\text{with } fs2 = (fs_jacket \cdot Asl, \text{com, jacket} + fs_core \cdot Asl, \text{com, core}) / Asl, \text{com} = 735.6545$$

$$\text{with } Es2 = (Es_jacket \cdot Asl, \text{com, jacket} + Es_core \cdot Asl, \text{com, core}) / Asl, \text{com} = 200000.00$$

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 937.50$$

$$fyv = 781.25$$

$$suv = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/ld = 1.00$$

$$suv = 0.4 \cdot esuv_nominal \text{ ((5.5), TB DY)} = 0.032$$

$$\text{From table 5A.1, TB DY: } esuv_nominal = 0.08,$$

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

For calculation of esuv_nominal and yv, shv, ftv, fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TB DY.

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

$$\text{with } fsv = (fs_jacket \cdot Asl, \text{mid, jacket} + fs_mid \cdot Asl, \text{mid, core}) / Asl, \text{mid} = 781.25$$

$$\text{with } Esv = (Es_jacket \cdot Asl, \text{mid, jacket} + Es_mid \cdot Asl, \text{mid, core}) / Asl, \text{mid} = 200000.00$$

$$1 = Asl, \text{ten} / (b \cdot d) \cdot (fs1 / fce) = 0.06860752$$

$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.12378842$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.04175429$
 and confined core properties:
 $b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 30.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.08477074$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.15295169$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.05159117$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.09460844$
 $Mu = M_{Rc} (4.14) = 4.6479E+008$
 $u = su (4.1) = 5.6369735E-005$

Calculation of ratio l_b/d

Adequate Lap Length: $l_b/d \geq 1$

Calculation of Mu_2 -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 6.0907698E-005$
 $Mu = 7.8817E+008$

with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.000307$
 $N = 2309.833$
 $f_c = 30.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0053097$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.0053097$
 $we (5.4c) = 0.00204688$
 $ase ((5.4d), TBDY) = (ase1*A_{ext} + ase2*A_{int})/A_{sec} = 0.14776895$
 $ase1 = 0.14776895$
 $bo_1 = 340.00$
 $ho_1 = 610.00$
 $bi2_1 = 975400.00$
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi2_2 = 557856.00$

$psh_{min}*F_{ywe} = \text{Min}(psh_x*F_{ywe}, psh_y*F_{ywe}) = 1.38519$
 Expression ((5.4d), TBDY) for $psh_{min}*F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh_x*F_{ywe} = psh1*F_{ywe1} + ps2*F_{ywe2} = 2.45559$
 $ps1 \text{ (external)} = (A_{sh1}*h1/s1)/A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir_1}*ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 670.00$
 $ps2 \text{ (internal)} = (A_{sh2}*h2/s2)/A_{sec} = 0.00062519$

Ash2 = Astir_2*ns_2 = 100.531
 No stirups, ns_2 = 2.00
 h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.38519
 ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
 Ash1 = Astir_1*ns_1 = 157.0796
 No stirups, ns_1 = 2.00
 h1 = 400.00
 ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
 Ash2 = Astir_2*ns_2 = 100.531
 No stirups, ns_2 = 2.00
 h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 781.25

fywe2 = 656.25

fce = 30.00

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

c = confinement factor = 1.00

y1 = 0.0025

sh1 = 0.008

ft1 = 882.7854

fy1 = 735.6545

su1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

lo/lou,min = lb/ld = 1.00

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

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

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

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

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 735.6545

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

y2 = 0.0025

sh2 = 0.008

ft2 = 872.4558

fy2 = 727.0465

su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

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

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

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

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

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 727.0465

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

yv = 0.0025

shv = 0.008

ftv = 937.50

fyv = 781.25

suv = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

lo/lou,min = lb/ld = 1.00

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

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

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
 For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered

characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY.
 y_1 , sh_1 , ft_1 , f_{y1} , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 781.25$
 with $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.12378842$
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.06860752$
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.04175429$

and confined core properties:

$b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $f_{cc} \text{ (5A.2, TBDY)} = 30.00$
 $cc \text{ (5A.5, TBDY)} = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.15295169$
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.08477074$
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.05159117$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is not satisfied

--->

$v < v_{s,c}$ - RHS eq.(4.5) is satisfied

--->

$su \text{ (4.8)} = 0.16206515$

$Mu = MR_c \text{ (4.15)} = 7.8817E+008$

$u = su \text{ (4.1)} = 6.0907698E-005$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 578810.994$

Calculation of Shear Strength at edge 1, $V_{r1} = 578810.994$

$V_{r1} = V_n \text{ ((22.5.1.1), ACI 318-14)}$

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ '
 where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 192813.976$
 $= 1$ (normal-weight concrete)

Mean concrete strength: $f'_c = (f'_{c,jacket} \cdot \text{Area}_{jacket} + f'_{c,core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 27.76119$, but $f_c^{0.5} \leq 8.3 \text{ MPa}$ (22.5.3.1, ACI 318-14)

$p_w = A_s / (b_w \cdot d) = 0.00331157$

$A_s \text{ (tension reinf.)} = 709.9999$

$b_w = 400.00$

$d = 536.00$

$V_u \cdot d / Mu < 1 = 1.00$

$Mu = 1.1510E+006$

$V_u = 9840.634$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 385997.017$

$V_{s1} = 350811.18$ is calculated for jacket, with:

$d = 536.00$

$A_v = 157079.633$

$f_y = 625.00$

$s = 150.00$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17, 10.3.4)

$V_{s2} = 35185.838$ is calculated for jacket, with:

$d_2 = 400.00$

$A_v = 100530.965$

$f_y = 525.00$

$s = 300.00$

Vs2 has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.50$$

$$V_f ((11-3)-(11.4), \text{ACI 440}) = 0.00$$

$$\text{From } (11-11), \text{ACI 440: } V_s + V_f \leq 750430.726$$

Calculation of Shear Strength at edge 2, $V_{r2} = 578810.994$

$$V_{r2} = V_n ((22.5.1.1), \text{ACI 318-14})$$

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw + f*Vf' where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 192813.976$

= 1 (normal-weight concrete)

Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot \text{Area}_{jacket} + f'_{c_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 27.76119$, but $f_c^{0.5} \leq 8.3 \text{ MPa}$ (22.5.3.1, ACI 318-14)

$$p_w = A_s / (b_w \cdot d) = 0.00331157$$

$$A_s (\text{tension reinf.}) = 709.9999$$

$$b_w = 400.00$$

$$d = 536.00$$

$$V_u \cdot d / M_u < 1 = 1.00$$

$$M_u = 1.1510 \text{E}+006$$

$$V_u = 9840.632$$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 385997.017$

$V_{s1} = 350811.18$ is calculated for jacket, with:

$$d = 536.00$$

$$A_v = 157079.633$$

$$f_y = 625.00$$

$$s = 150.00$$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 35185.838$ is calculated for jacket, with:

$$d = 400.00$$

$$A_v = 100530.965$$

$$f_y = 525.00$$

$$s = 300.00$$

V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.50$$

$$V_f ((11-3)-(11.4), \text{ACI 440}) = 0.00$$

$$\text{From } (11-11), \text{ACI 440: } V_s + V_f \leq 750430.726$$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 2

(Bending local axis: 3)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\phi = 0.87$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

#####

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,  $f_s = 1.25 \cdot f_{sm} = 781.25$ 
Existing Column
Existing material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 656.25$ 
#####
External Height,  $H = 670.00$ 
External Width,  $W = 400.00$ 
Internal Height,  $H = 500.00$ 
Internal Width,  $W = 200.00$ 
Cover Thickness,  $c = 25.00$ 
Mean Confinement Factor overall section = 1.00
Element Length,  $L = 3000.00$ 
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length ( $l_o/l_{ou}, \min > 1$ )
No FRP Wrapping
-----

Stepwise Properties
-----
At local axis: 2
EDGE -A-
Shear Force,  $V_a = -9.0372119E-015$ 
EDGE -B-
Shear Force,  $V_b = 9.0372119E-015$ 
BOTH EDGES
Axial Force,  $F = -2309.833$ 
Longitudinal Reinforcement Area Distribution (in 2 divisions)
  -Tension:  $As_t = 709.9999$ 
  -Compression:  $As_c = 1668.186$ 
Longitudinal Reinforcement Area Distribution (in 3 divisions)
  -Tension:  $As_{t,ten} = 911.0619$ 
  -Compression:  $As_{t,com} = 911.0619$ 
  -Middle:  $As_{t,mid} = 556.0619$ 
-----
-----

Calculation of Shear Capacity ratio ,  $V_e/V_r = 0.55914272$ 
Member Controlled by Flexure ( $V_e/V_r < 1$ )
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 218168.257$ 
with
 $M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 3.2725E+008$ 
 $\mu_{u1+} = 3.2725E+008$ , 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
 $\mu_{u1-} = 3.2725E+008$ , 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
 $M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 3.2725E+008$ 
 $\mu_{u2+} = 3.2725E+008$ , 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
 $\mu_{u2-} = 3.2725E+008$ , 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
and
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$ 
with
 $V_1 = -9.0372119E-015$ , is the shear force acting at edge 1 for the the static loading combination
 $V_2 = 9.0372119E-015$ , is the shear force acting at edge 2 for the the static loading combination

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Calculation of  $\mu_{u1+}$ 
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-----

```

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

$$\phi_u = 0.00010507$$

$$M_u = 3.2725E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.0003219$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$\omega (5A.5, \text{TBDY}) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.0053097$$

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

$$\text{From (5.4b), TBDY: } \phi_u = 0.0053097$$

$$w_e (5.4c) = 0.00204688$$

$$a_{se} ((5.4d), \text{TBDY}) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$\text{psh_min} * F_{ywe} = \text{Min}(\text{psh_x} * F_{ywe}, \text{psh_y} * F_{ywe}) = 1.38519$$

Expression ((5.4d), TBDY) for $\text{psh_min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\text{psh_x} * F_{ywe} = \text{psh}_1 * F_{ywe1} + \text{ps}_2 * F_{ywe2} = 2.45559$$

$$\text{ps}_1 (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$\text{ps}_2 (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$\text{psh_y} * F_{ywe} = \text{psh}_1 * F_{ywe1} + \text{ps}_2 * F_{ywe2} = 1.38519$$

$$\text{ps}_1 (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$\text{ps}_2 (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$f_{t1} = 886.8103$$

$$f_{y1} = 739.0086$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$l_o / l_{ou, \text{min}} = l_b / l_d = 1.00$$

$$su_1 = 0.4 * esu_{1_nominal} ((5.5), \text{TBDY}) = 0.032$$

From table 5A.1, TBDY: $esu1_nominal = 0.08$,
For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fs1 = (fs_jacket \cdot Asl_ten_jacket + fs_core \cdot Asl_ten_core) / Asl_ten = 739.0086$
with $Es1 = (Es_jacket \cdot Asl_ten_jacket + Es_core \cdot Asl_ten_core) / Asl_ten = 200000.00$
 $y2 = 0.0025$
 $sh2 = 0.008$
 $ft2 = 886.8103$
 $fy2 = 739.0086$
 $su2 = 0.032$
using (30) in Biskinis/Fardis (2013) multiplied with $shear_factor$
and also multiplied by the $shear_factor$ according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou, min = lb/lb, min = 1.00$
 $su2 = 0.4 \cdot esu2_nominal ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esu2_nominal = 0.08$,
For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fs2 = (fs_jacket \cdot Asl_com_jacket + fs_core \cdot Asl_com_core) / Asl_com = 739.0086$
with $Es2 = (Es_jacket \cdot Asl_com_jacket + Es_core \cdot Asl_com_core) / Asl_com = 200000.00$
 $yv = 0.0025$
 $shv = 0.008$
 $ftv = 895.9746$
 $fyv = 746.6455$
 $suv = 0.032$
using (30) in Biskinis/Fardis (2013) multiplied with $shear_factor$
and also multiplied by the $shear_factor$ according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou, min = lb/ld = 1.00$
 $suv = 0.4 \cdot esuv_nominal ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esuv_nominal = 0.08$,
considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered
characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fsv = (fs_jacket \cdot Asl_mid_jacket + fs_mid \cdot Asl_mid_core) / Asl_mid = 746.6455$
with $Es_v = (Es_jacket \cdot Asl_mid_jacket + Es_mid \cdot Asl_mid_core) / Asl_mid = 200000.00$
 $1 = Asl_ten / (b \cdot d) \cdot (fs1 / fc) = 0.09382814$
 $2 = Asl_com / (b \cdot d) \cdot (fs2 / fc) = 0.09382814$
 $v = Asl_mid / (b \cdot d) \cdot (fsv / fc) = 0.05785932$
and confined core properties:
 $b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 30.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl_ten / (b \cdot d) \cdot (fs1 / fc) = 0.11251192$
 $2 = Asl_com / (b \cdot d) \cdot (fs2 / fc) = 0.11251192$
 $v = Asl_mid / (b \cdot d) \cdot (fsv / fc) = 0.06938071$
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)
--->
 $v < v_{s,c}$ - RHS eq.(4.5) is satisfied
--->
 $su (4.9) = 0.1468828$
 $Mu = MRc (4.14) = 3.2725E+008$
 $u = su (4.1) = 0.00010507$

Calculation of ratio lb/ld

Adequate Lap Length: $lb/ld \geq 1$

Calculation of Mu1-

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

$$\mu = 0.00010507$$

$$\mu_u = 3.2725 \times 10^8$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.0003219$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$c_o(5A.5, \text{TBDY}) = 0.002$$

$$\text{Final value of } \mu_u: \mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, \mu_c) = 0.0053097$$

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

$$\text{From (5.4b), TBDY: } \mu_u = 0.0053097$$

$$\mu_{ue}(5.4c) = 0.00204688$$

$$\mu_{ue}((5.4d), \text{TBDY}) = (\mu_{ue1} * A_{ext} + \mu_{ue2} * A_{int}) / A_{sec} = 0.14776895$$

$$\mu_{ue1} = 0.14776895$$

$$b_{o1} = 340.00$$

$$h_{o1} = 610.00$$

$$b_{i21} = 975400.00$$

$$\mu_{ue2} = \text{Max}(\mu_{ue1}, \mu_{ue2}) = 0.14776895$$

$$b_{o2} = 192.00$$

$$h_{o2} = 492.00$$

$$b_{i22} = 557856.00$$

$$\mu_{psh,min} * F_{ywe} = \text{Min}(\mu_{psh,x} * F_{ywe}, \mu_{psh,y} * F_{ywe}) = 1.38519$$

Expression ((5.4d), TBDY) for $\mu_{psh,min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\mu_{psh,x} * F_{ywe} = \mu_{psh1} * F_{ywe1} + \mu_{psh2} * F_{ywe2} = 2.45559$$

$$\mu_{psh1}(\text{external}) = (\mu_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$\mu_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$\mu_{psh2}(\text{internal}) = (\mu_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$\mu_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$\mu_{psh,y} * F_{ywe} = \mu_{psh1} * F_{ywe1} + \mu_{psh2} * F_{ywe2} = 1.38519$$

$$\mu_{psh1}(\text{external}) = (\mu_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$\mu_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$\mu_{psh2}(\text{internal}) = (\mu_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$\mu_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TBDY), TBDY: } c_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 886.8103$$

$$fy_1 = 739.0086$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 1.00$
 $su_1 = 0.4 * esu_{1,nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{1,nominal} = 0.08$,
 For calculation of $esu_{1,nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered
 characteristic value $fsy_1 = fs_1/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_1 = (fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 739.0086$
 with $Es_1 = (Es_{jacket} * A_{sl,ten,jacket} + Es_{core} * A_{sl,ten,core}) / A_{sl,ten} = 200000.00$
 $y_2 = 0.0025$
 $sh_2 = 0.008$
 $ft_2 = 886.8103$
 $fy_2 = 739.0086$
 $su_2 = 0.032$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 1.00$
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,
 For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_2, sh_2, ft_2, fy_2 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 739.0086$
 with $Es_2 = (Es_{jacket} * A_{sl,com,jacket} + Es_{core} * A_{sl,com,core}) / A_{sl,com} = 200000.00$
 $y_v = 0.0025$
 $sh_v = 0.008$
 $ft_v = 895.9746$
 $fy_v = 746.6455$
 $suv = 0.032$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 1.00$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs_{jacket} * A_{sl,mid,jacket} + fs_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 746.6455$
 with $Esv = (Es_{jacket} * A_{sl,mid,jacket} + Es_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$
 $1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.09382814$
 $2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.09382814$
 $v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.05785932$
 and confined core properties:
 $b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 30.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.11251192$
 $2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.11251192$
 $v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.06938071$
 Case/Assumption: Unconfined full section - Steel rupture
 ' does not satisfy Eq. (4.3)
 --->
 $v < v_{s,c}$ - RHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.1468828$
 $Mu = MRc (4.14) = 3.2725E+008$
 $u = su (4.1) = 0.00010507$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of μ_{2+}

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

$$\mu = 0.00010507$$

$$\mu_u = 3.2725E+008$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.0003219$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$c_o \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } \mu_u: \mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, c_o) = 0.0053097$$

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

$$\text{From (5.4b), TBDY: } \mu_u = 0.0053097$$

$$\mu_{ue} \text{ (5.4c)} = 0.00204688$$

$$a_{se} \text{ ((5.4d), TBDY)} = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh,min} * F_{ywe} = \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.38519$$

Expression ((5.4d), TBDY) for $p_{sh,min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh,x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.45559$$

$$p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$p_{sh,y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.38519$$

$$p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TBDY), TBDY: } c_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

```

y1 = 0.0025
sh1 = 0.008
ft1 = 886.8103
fy1 = 739.0086
su1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 739.0086
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 886.8103
fy2 = 739.0086
su2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 739.0086
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 895.9746
fyv = 746.6455
suv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 746.6455
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09382814
2 = Asl,com/(b*d)*(fs2/fc) = 0.09382814
v = Asl,mid/(b*d)*(fsv/fc) = 0.05785932
and confined core properties:
b = 610.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11251192
2 = Asl,com/(b*d)*(fs2/fc) = 0.11251192
v = Asl,mid/(b*d)*(fsv/fc) = 0.06938071
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)
---->
v < vs,c - RHS eq.(4.5) is satisfied
---->

```


$\mu_u(4.9) = 0.1468828$
 $\mu_u = M_{Rc}(4.14) = 3.2725E+008$
 $u = \mu_u(4.1) = 0.00010507$

Calculation of ratio I_b/I_d

Adequate Lap Length: $I_b/I_d \geq 1$

Calculation of μ_{u2} -

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

$u = 0.00010507$
 $\mu_u = 3.2725E+008$

with full section properties:

$b = 670.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.0003219$
 $N = 2309.833$
 $f_c = 30.00$
 $\alpha(5A.5, TBDY) = 0.002$
 Final value of μ_u : $\mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, \mu_c) = 0.0053097$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $\mu_u = 0.0053097$
 $\mu_{ue}(5.4c) = 0.00204688$
 $\alpha_{se}((5.4d), TBDY) = (\alpha_{se1} * A_{ext} + \alpha_{se2} * A_{int}) / A_{sec} = 0.14776895$
 $\alpha_{se1} = 0.14776895$
 $b_{o_1} = 340.00$
 $h_{o_1} = 610.00$
 $b_{i2_1} = 975400.00$
 $\alpha_{se2} = \text{Max}(\alpha_{se1}, \alpha_{se2}) = 0.14776895$
 $b_{o_2} = 192.00$
 $h_{o_2} = 492.00$
 $b_{i2_2} = 557856.00$

$\mu_{psh,min} * F_{ywe} = \text{Min}(\mu_{psh,x} * F_{ywe}, \mu_{psh,y} * F_{ywe}) = 1.38519$

Expression ((5.4d), TBDY) for $\mu_{psh,min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$\mu_{psh,x} * F_{ywe} = \mu_{psh1} * F_{ywe1} + \mu_{psh2} * F_{ywe2} = 2.45559$
 $\mu_{psh1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h_1 = 670.00$
 $\mu_{psh2}(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirrups, $n_{s_2} = 2.00$
 $h_2 = 500.00$

$\mu_{psh,y} * F_{ywe} = \mu_{psh1} * F_{ywe1} + \mu_{psh2} * F_{ywe2} = 1.38519$
 $\mu_{psh1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h_1 = 400.00$
 $\mu_{psh2}(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirrups, $n_{s_2} = 2.00$
 $h_2 = 200.00$

$A_{sec} = 268000.00$
 $s_1 = 150.00$
 $s_2 = 300.00$

```

fywe1 = 781.25
fywe2 = 656.25
fce = 30.00
From ((5.A.5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.0025
sh1 = 0.008
ft1 = 886.8103
fy1 = 739.0086
su1 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 739.0086
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 886.8103
fy2 = 739.0086
su2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 739.0086
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 895.9746
fyv = 746.6455
suv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by  $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$ , from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 746.6455
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09382814
2 = Asl,com/(b*d)*(fs2/fc) = 0.09382814
v = Asl,mid/(b*d)*(fsv/fc) = 0.05785932
and confined core properties:
b = 610.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11251192
2 = Asl,com/(b*d)*(fs2/fc) = 0.11251192
v = Asl,mid/(b*d)*(fsv/fc) = 0.06938071

```

Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)

--->
 $v < v_{s,c}$ - RHS eq.(4.5) is satisfied

--->
 $\mu_u (4.9) = 0.1468828$
 $\mu_u = M_{Rc} (4.14) = 3.2725E+008$
 $u = \mu_u (4.1) = 0.00010507$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of Shear Strength $V_r = \min(V_{r1}, V_{r2}) = 390183.487$

Calculation of Shear Strength at edge 1, $V_{r1} = 390183.487$
 $V_{r1} = V_n ((22.5.1.1), \text{ACI } 318-14)$

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f_v V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 180743.977$
 $= 1$ (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_c_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f'_c_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 27.76119$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 670.00$
 $d = 320.00$
 $V_u \cdot d / \mu_u < 1 = 0.00$
 $\mu_u = 6.8565666E-012$
 $V_u = 9.0372119E-015$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 209439.51$
 $V_{s1} = 209439.51$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 625.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 0.00$ is calculated for jacket, with:
 $d_2 = 160.00$
 $A_v = 100530.965$
 $f_y = 525.00$
 $s = 300.00$
 V_{s2} is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)
 $V_f ((11-3)-(11.4), \text{ACI } 440) = 0.00$
From (11-11), ACI 440: $V_s + V_f \leq 750430.726$

Calculation of Shear Strength at edge 2, $V_{r2} = 390183.487$
 $V_{r2} = V_n ((22.5.1.1), \text{ACI } 318-14)$

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f_v V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 180743.977$
 $= 1$ (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_c_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f'_c_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 27.76119$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 670.00$
 $d = 320.00$
 $V_u \cdot d / \mu_u < 1 = 0.00$

$$Mu = 2.0256286E-011$$

$$Vu = 9.0372119E-015$$

From (11.5.4.8), ACI 318-14: $Vs1 + Vs2 = 209439.51$

$Vs1 = 209439.51$ is calculated for jacket, with:

$$d = 320.00$$

$$Av = 157079.633$$

$$fy = 625.00$$

$$s = 150.00$$

$Vs1$ has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$Vs2 = 0.00$ is calculated for jacket, with:

$$d = 160.00$$

$$Av = 100530.965$$

$$fy = 525.00$$

$$s = 300.00$$

$Vs2$ is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)

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

From (11-11), ACI 440: $Vs + Vf \leq 750430.726$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 0.87$

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, $f_c = f_{cm} = 30.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_b/l_d \geq 1$)

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 2.8583610E-011$

Shear Force, $V2 = 2.4489115E-014$

Shear Force, $V3 = 1166.41$

Axial Force, $F = -9608.729$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $Asl_t = 709.9999$
 -Compression: $Asl_c = 1668.186$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $Asl_{ten} = 911.0619$
 -Compression: $Asl_{com} = 911.0619$
 -Middle: $Asl_{mid} = 556.0619$
 Longitudinal External Reinforcement Area Distribution (in 3 divisions)
 -Tension: $Asl_{ten,jacket} = 603.1858$
 -Compression: $Asl_{com,jacket} = 603.1858$
 -Middle: $Asl_{mid,jacket} = 402.1239$
 Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $Asl_{ten,core} = 307.8761$
 -Compression: $Asl_{com,core} = 307.8761$
 -Middle: $Asl_{mid,core} = 153.938$
 Mean Diameter of Tension Reinforcement, $DbL = 15.20$

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = \frac{1}{2} u = 0.02097574$
 $u = \frac{1}{2} y + \frac{1}{2} p = 0.02411005$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.00411005$ ((4.29), Biskinis Phd))
 $M_y = 2.1288E+008$
 $L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 1500.00
 From table 10.5, ASCE 41_17: $E_{eff} = 0.3 * E_c * I_g = 2.5898E+013$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$
 $y_{ten} = 1.0755102E-005$
 with $f_y = 625.00$
 $d = 357.00$
 $y = 0.22825315$
 $A = 0.01001045$
 $B = 0.0056379$
 with $p_t = 0.00380895$
 $p_c = 0.00380895$
 $p_v = 0.00232477$
 $N = 9608.729$
 $b = 670.00$
 $\alpha = 0.12044818$
 $y_{comp} = 2.5830452E-005$
 with $f_c = 27.76119$
 $E_c = 25742.96$
 $y = 0.22747572$
 $A = 0.00984691$
 $B = 0.00557012$
 with $E_s = 200000.00$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

- Calculation of p -

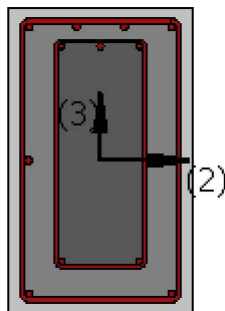
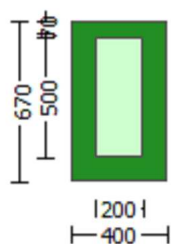
From table 10-7: $p = 0.02$
 with:

- Condition i occurred
Beam controlled by flexure: $V_p/V_o \leq 1$
shear control ratio $V_p/V_o = 0.55914272$
- Transverse Reinforcement: NC
- Stirrup Spacing $> d/3$
- Low ductility demand, $\lambda / y < 2$ (table 10-6, ASCE 41-17)
 $= -5.0103204E-022$
- Stirrup Spacing $\leq d/2$
 $d = d_{\text{external}} = 357.00$
 $s = s_{\text{external}} = 150.00$
- Strength provided by hoops $V_s < 3/4 \cdot \text{design Shear}$
 $V_s = 237588.18$, already given in calculation of shear control ratio
design Shear = $2.4489115E-014$
- (-)/ bal = -0.33327376
 $= A_{st}/(b_w \cdot d) = 0.00296835$
Tension Reinf Area: $A_{st} = 709.9999$
 $' = A_{sc}/(b_w \cdot d) = 0.00697431$
Compression Reinf Area: $A_{sc} = 1668.186$
From (B-1), ACI 318-11: bal = 0.01202003
 $f_c = (f_{c_jacket} \cdot \text{Area}_{jacket} + f_{c_core} \cdot \text{Area}_{core}) / \text{section_area} = 27.76119$
 $f_y = f_{y_jacket_bars} = 625.00$
From 10.2.7.3, ACI 318-11: $\lambda = 0.65$
From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000 / (87000 + f_y) = c_b/d_t = 0.003 / (0.003 + y) = 0.48979592$
 $y = 0.003125$
- $V / (b_w \cdot d \cdot f_c^{0.5}) = 2.3400990E-019$, NOTE: units in lb & in
 $b_w = 670.00$

End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1
At local axis: 3
Integration Section: (a)

Calculation No. 13

beam B1, Floor 1
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)
Analysis: Uniform +X
Check: Shear capacity V_{Rd}
Edge: End
Local Axis: (2)



Start Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (b)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 0.87$

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, $f_c = f_{c_lower_bound} = 20.00$

New material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 420.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_o/l_{ou,min} = l_b/l_d \geq 1$)

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 2.8583610E-011$

Shear Force, $V_a = 2.4489115E-014$

EDGE -B-

Bending Moment, $M_b = 4.4683392E-011$

Shear Force, $V_b = -2.4489115E-014$

BOTH EDGES

Axial Force, $F = -9608.729$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 709.9999$

-Compression: $As_c = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten} = 911.0619$

-Compression: $As_{l,com} = 911.0619$

-Middle: $Asl_{mid} = 556.0619$
Mean Diameter of Tension Reinforcement, $DbL_{ten} = 15.20$

Existing component: From table 7-7, ASCE 41-17: Final Shear Capacity $V_R = V_n = 274161.749$
 $V_n ((22.5.1.1), ACI 318-14) = 315128.448$

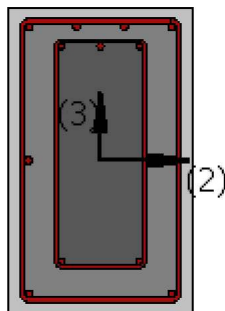
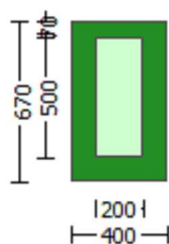
NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f^*V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 147576.839$
= 1 (normal-weight concrete)
Mean concrete strength: $f_c' = (f_c'_{jacket} \cdot Area_{jacket} + f_c'_{core} \cdot Area_{core}) / Area_{section} = 18.50746$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = As / (b_w \cdot d) = 0.00331157$
 As (tension reinf.) = 709.9999
 $b_w = 670.00$
 $d = 320.00$
 $V_u \cdot d / M_u < 1 = 0.00$
 $M_u = 4.4683392E-011$
 $V_u = 2.4489115E-014$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 167551.608$
 $V_{s1} = 167551.608$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 500.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17, 10.3.4)
 $V_{s2} = 0.00$ is calculated for core, with:
 $d = 160.00$
 $A_v = 100530.965$
 $f_y = 420.00$
 $s = 300.00$
 V_{s2} is considered 0 ($s > d$, according to ASCE 41-17, 10.3.4)
 $V_f ((11-3)-(11.4), ACI 440) = 0.00$
From (11-11), ACI 440: $V_s + V_f \leq 612724.122$

End Of Calculation of Shear Capacity for element: beam JB1 of floor 1
At local axis: 2
Integration Section: (b)

Calculation No. 14

beam B1, Floor 1
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)
Analysis: Uniform +X
Check: Chord rotation capacity (θ_r)
Edge: End
Local Axis: (2)



Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 0.87$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

#####

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, $f_s = 1.25 \cdot f_{sm} = 781.25$

Existing Column

Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 656.25$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_o/l_{ou, \min} \geq 1$)

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = 9840.634$

EDGE -B-

Shear Force, $V_b = 9840.632$

BOTH EDGES

Axial Force, $F = -2309.833$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $As_t = 709.9999$
 -Compression: $As_c = 1668.186$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten} = 709.9999$
 -Compression: $As_{c,com} = 1266.062$
 -Middle: $As_{mid} = 402.1239$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.92480584$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 535287.788$
 with
 $M_{pr1} = \text{Max}(\mu_{1+}, \mu_{1-}) = 7.8817E+008$
 $\mu_{1+} = 4.6479E+008$, 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
 $\mu_{1-} = 7.8817E+008$, 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
 $M_{pr2} = \text{Max}(\mu_{2+}, \mu_{2-}) = 7.8817E+008$
 $\mu_{2+} = 4.6479E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the static loading combination
 $\mu_{2-} = 7.8817E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination
 and
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$
 with
 $V_1 = 9840.634$, is the shear force acting at edge 1 for the static loading combination
 $V_2 = 9840.632$, is the shear force acting at edge 2 for the static loading combination

Calculation of μ_{1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 5.6369735E-005$
 $M_u = 4.6479E+008$

with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.000307$
 $N = 2309.833$
 $f_c = 30.00$
 $\phi_c \text{ (5A.5, TBDY)} = 0.002$
 Final value of ϕ_u : $\phi_u^* = \text{shear_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.0053097$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $\phi_u = 0.0053097$
 $w_e \text{ (5.4c)} = 0.00204688$
 $\phi_{se} \text{ ((5.4d), TBDY)} = (\phi_{se1} \cdot A_{ext} + \phi_{se2} \cdot A_{int})/A_{sec} = 0.14776895$
 $\phi_{se1} = 0.14776895$
 $b_{o_1} = 340.00$
 $h_{o_1} = 610.00$
 $b_{i2_1} = 975400.00$
 $\phi_{se2} = \text{Max}(\phi_{se1}, \phi_{se2}) = 0.14776895$
 $b_{o_2} = 192.00$
 $h_{o_2} = 492.00$
 $b_{i2_2} = 557856.00$
 $\phi_{sh,min} \cdot F_{ywe} = \text{Min}(\phi_{sh,x} \cdot F_{ywe}, \phi_{sh,y} \cdot F_{ywe}) = 1.38519$
 Expression ((5.4d), TBDY) for $\phi_{sh,min} \cdot F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$\phi_{sh,x} \cdot F_{ywe} = \phi_{sh1} \cdot F_{ywe1} + \phi_{sh2} \cdot F_{ywe2} = 2.45559$

$ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00261799$
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$
 $No \text{ stirups, } ns_1 = 2.00$
 $h1 = 670.00$
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00062519$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 $No \text{ stirups, } ns_2 = 2.00$
 $h2 = 500.00$

$psh_y \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 1.38519$
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00156298$
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$
 $No \text{ stirups, } ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00025008$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 $No \text{ stirups, } ns_2 = 2.00$
 $h2 = 200.00$

$Asec = 268000.00$
 $s1 = 150.00$
 $s2 = 300.00$
 $fywe1 = 781.25$
 $fywe2 = 656.25$
 $fce = 30.00$

From ((5.A5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$

$y1 = 0.0025$
 $sh1 = 0.008$
 $ft1 = 872.4558$
 $fy1 = 727.0465$
 $su1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou, min = lb/ld = 1.00$

$su1 = 0.4 \cdot esu1_nominal \text{ ((5.5), TBDY)} = 0.032$

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

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

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

with $fs1 = (fs_jacket \cdot Asl, ten, jacket + fs_core \cdot Asl, ten, core) / Asl, ten = 727.0465$

with $Es1 = (Es_jacket \cdot Asl, ten, jacket + Es_core \cdot Asl, ten, core) / Asl, ten = 200000.00$

$y2 = 0.0025$
 $sh2 = 0.008$
 $ft2 = 882.7854$
 $fy2 = 735.6545$
 $su2 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$

$lo/lou, min = lb/lb, min = 1.00$

$su2 = 0.4 \cdot esu2_nominal \text{ ((5.5), TBDY)} = 0.032$

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

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

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

with $fs2 = (fs_jacket \cdot Asl, com, jacket + fs_core \cdot Asl, com, core) / Asl, com = 735.6545$

with $Es2 = (Es_jacket \cdot Asl, com, jacket + Es_core \cdot Asl, com, core) / Asl, com = 200000.00$

$yv = 0.0025$
 $shv = 0.008$
 $ftv = 937.50$
 $fyv = 781.25$
 $suv = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$

$l_o/l_{ou,min} = l_b/l_d = 1.00$
 $s_{uv} = 0.4 * e_{suv_nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $e_{suv_nominal} = 0.08$,
 considering characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY
 For calculation of $e_{suv_nominal}$ and y_v , sh_v , ft_v , f_{yv} , it is considered
 characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY.
 y_1 , sh_1 , ft_1 , f_{y1} , are also multiplied by $\text{Min}(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{sv} = (f_{sj,jacket} * A_{sl,mid,jacket} + f_{s,mid} * A_{sl,mid,core}) / A_{sl,mid} = 781.25$
 with $E_{sv} = (E_{sj,jacket} * A_{sl,mid,jacket} + E_{s,mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$
 $1 = A_{sl,ten} / (b * d) * (f_{s1}/f_c) = 0.06860752$
 $2 = A_{sl,com} / (b * d) * (f_{s2}/f_c) = 0.12378842$
 $v = A_{sl,mid} / (b * d) * (f_{sv}/f_c) = 0.04175429$
 and confined core properties:
 $b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 30.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten} / (b * d) * (f_{s1}/f_c) = 0.08477074$
 $2 = A_{sl,com} / (b * d) * (f_{s2}/f_c) = 0.15295169$
 $v = A_{sl,mid} / (b * d) * (f_{sv}/f_c) = 0.05159117$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.09460844$
 $M_u = M_{Rc} (4.14) = 4.6479E+008$
 $u = su (4.1) = 5.6369735E-005$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of M_{u1} -

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

$u = 6.0907698E-005$
 $M_u = 7.8817E+008$

with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.000307$
 $N = 2309.833$
 $f_c = 30.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0053097$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.0053097$
 $we (5.4c) = 0.00204688$
 $ase ((5.4d), TBDY) = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$
 $ase1 = 0.14776895$
 $bo_1 = 340.00$
 $ho_1 = 610.00$
 $bi2_1 = 975400.00$
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi2_2 = 557856.00$

$psh,min*Fywe = \text{Min}(psh,x*Fywe, psh,y*Fywe) = 1.38519$
 Expression ((5.4d), TBDY) for $psh,min*Fywe$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh_x*Fywe = psh1*Fywe1 + ps2*Fywe2 = 2.45559$
 $ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00261799$
 $Ash1 = Astir_1*ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 670.00$
 $ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00062519$
 $Ash2 = Astir_2*ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 500.00$

$psh_y*Fywe = psh1*Fywe1 + ps2*Fywe2 = 1.38519$
 $ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00156298$
 $Ash1 = Astir_1*ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00025008$
 $Ash2 = Astir_2*ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

$Asec = 268000.00$
 $s1 = 150.00$
 $s2 = 300.00$
 $fywe1 = 781.25$
 $fywe2 = 656.25$
 $fce = 30.00$

From ((5.A5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$

$y1 = 0.0025$
 $sh1 = 0.008$
 $ft1 = 882.7854$
 $fy1 = 735.6545$
 $su1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/ld = 1.00$

$su1 = 0.4*esu1_nominal \text{ ((5.5), TBDY)} = 0.032$

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

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

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

with $fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 735.6545$

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

$y2 = 0.0025$
 $sh2 = 0.008$
 $ft2 = 872.4558$
 $fy2 = 727.0465$
 $su2 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lou,min = lb/lb,min = 1.00$

$su2 = 0.4*esu2_nominal \text{ ((5.5), TBDY)} = 0.032$

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

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

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

with $fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 727.0465$

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

$yv = 0.0025$
 $shv = 0.008$
 $ftv = 937.50$

```

fyv = 781.25
suv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lo,min = lb/ld = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fsjacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 781.25
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.12378842
2 = Asl,com/(b*d)*(fs2/fc) = 0.06860752
v = Asl,mid/(b*d)*(fsv/fc) = 0.04175429
and confined core properties:
b = 340.00
d = 597.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.15295169
2 = Asl,com/(b*d)*(fs2/fc) = 0.08477074
v = Asl,mid/(b*d)*(fsv/fc) = 0.05159117
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.8) = 0.16206515
Mu = MRc (4.15) = 7.8817E+008
u = su (4.1) = 6.0907698E-005

```

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu2+

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

```

u = 5.6369735E-005
Mu = 4.6479E+008

```

with full section properties:

```

b = 400.00
d = 627.00
d' = 43.00
v = 0.000307
N = 2309.833
fc = 30.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.0053097
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0053097
we (5.4c) = 0.00204688
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.14776895
ase1 = 0.14776895

```

$bo_1 = 340.00$
 $ho_1 = 610.00$
 $bi2_1 = 975400.00$
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi2_2 = 557856.00$
 $psh, min*Fywe = \text{Min}(psh, x*Fywe, psh, y*Fywe) = 1.38519$
 Expression ((5.4d), TBDY) for $psh, min*Fywe$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh_x*Fywe = psh1*Fywe1 + ps2*Fywe2 = 2.45559$
 $ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00261799$
 $Ash1 = Astir_1*ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 670.00$
 $ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00062519$
 $Ash2 = Astir_2*ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 500.00$

$psh_y*Fywe = psh1*Fywe1 + ps2*Fywe2 = 1.38519$
 $ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00156298$
 $Ash1 = Astir_1*ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00025008$
 $Ash2 = Astir_2*ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

$Asec = 268000.00$
 $s1 = 150.00$
 $s2 = 300.00$
 $fywe1 = 781.25$
 $fywe2 = 656.25$
 $fce = 30.00$

From ((5.A5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$

$y1 = 0.0025$
 $sh1 = 0.008$
 $ft1 = 872.4558$
 $fy1 = 727.0465$
 $su1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lou, min = lb/l_d = 1.00$

$su1 = 0.4*esu1_nominal \text{ ((5.5), TBDY)} = 0.032$

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

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

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

with $fs1 = (fs_jacket*Asl, ten, jacket + fs_core*Asl, ten, core)/Asl, ten = 727.0465$

with $Es1 = (Es_jacket*Asl, ten, jacket + Es_core*Asl, ten, core)/Asl, ten = 200000.00$

$y2 = 0.0025$
 $sh2 = 0.008$
 $ft2 = 882.7854$
 $fy2 = 735.6545$
 $su2 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lou, min = lb/l_b, min = 1.00$

$su2 = 0.4*esu2_nominal \text{ ((5.5), TBDY)} = 0.032$

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

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

characteristic value $f_{sy2} = f_{s2}/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{s2} = (f_{sjacket} \cdot A_{sl,com,jacket} + f_{s,core} \cdot A_{sl,com,core})/A_{sl,com} = 735.6545$
 with $E_{s2} = (E_{sjacket} \cdot A_{sl,com,jacket} + E_{s,core} \cdot A_{sl,com,core})/A_{sl,com} = 200000.00$
 $y_v = 0.0025$
 $sh_v = 0.008$
 $ft_v = 937.50$
 $fy_v = 781.25$
 $suv = 0.032$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 1.00$
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{sv} = (f_{sjacket} \cdot A_{sl,mid,jacket} + f_{s,mid} \cdot A_{sl,mid,core})/A_{sl,mid} = 781.25$
 with $E_{sv} = (E_{sjacket} \cdot A_{sl,mid,jacket} + E_{s,mid} \cdot A_{sl,mid,core})/A_{sl,mid} = 200000.00$
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.06860752$
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.12378842$
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.04175429$

and confined core properties:

$b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 30.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.08477074$
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.15295169$
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.05159117$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$su (4.9) = 0.09460844$
 $\mu_u = MR_c (4.14) = 4.6479E+008$
 $u = su (4.1) = 5.6369735E-005$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of μ_{u2} -

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

$u = 6.0907698E-005$
 $\mu_u = 7.8817E+008$

with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.000307$
 $N = 2309.833$
 $f_c = 30.00$
 $cc (5A.5, TBDY) = 0.002$
 Final value of μ_u : $\mu_u^* = \text{shear_factor} \cdot \text{Max}(\mu_u, cc) = 0.0053097$

The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $c_u = 0.0053097$
 w_e (5.4c) = 0.00204688
 a_{se} ((5.4d), TBDY) = $(a_{se1} \cdot A_{ext} + a_{se2} \cdot A_{int}) / A_{sec} = 0.14776895$
 $a_{se1} = 0.14776895$
 $b_{o_1} = 340.00$
 $h_{o_1} = 610.00$
 $b_{i2_1} = 975400.00$
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$
 $b_{o_2} = 192.00$
 $h_{o_2} = 492.00$
 $b_{i2_2} = 557856.00$
 $p_{sh, \min} \cdot F_{ywe} = \text{Min}(p_{sh, x} \cdot F_{ywe}, p_{sh, y} \cdot F_{ywe}) = 1.38519$
 Expression ((5.4d), TBDY) for $p_{sh, \min} \cdot F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh, x} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{s2} \cdot F_{ywe2} = 2.45559$
 p_{s1} (external) = $(A_{sh1} \cdot h_1 / s_1) / A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir_1} \cdot n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h_1 = 670.00$
 p_{s2} (internal) = $(A_{sh2} \cdot h_2 / s_2) / A_{sec} = 0.00062519$
 $A_{sh2} = A_{stir_2} \cdot n_{s_2} = 100.531$
 No stirrups, $n_{s_2} = 2.00$
 $h_2 = 500.00$

$p_{sh, y} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{s2} \cdot F_{ywe2} = 1.38519$
 p_{s1} (external) = $(A_{sh1} \cdot h_1 / s_1) / A_{sec} = 0.00156298$
 $A_{sh1} = A_{stir_1} \cdot n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h_1 = 400.00$
 p_{s2} (internal) = $(A_{sh2} \cdot h_2 / s_2) / A_{sec} = 0.00025008$
 $A_{sh2} = A_{stir_2} \cdot n_{s_2} = 100.531$
 No stirrups, $n_{s_2} = 2.00$
 $h_2 = 200.00$

$A_{sec} = 268000.00$
 $s_1 = 150.00$
 $s_2 = 300.00$
 $f_{ywe1} = 781.25$
 $f_{ywe2} = 656.25$
 $f_{ce} = 30.00$

From ((5.A5), TBDY), TBDY: $c_c = 0.002$
 c = confinement factor = 1.00

$y_1 = 0.0025$
 $sh_1 = 0.008$
 $ft_1 = 882.7854$
 $fy_1 = 735.6545$
 $su_1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

$l_o / l_{ou, \min} = l_b / l_d = 1.00$

$su_1 = 0.4 \cdot esu_{1_nominal}$ ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: $esu_{1_nominal} = 0.08$,

For calculation of $esu_{1_nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered
 characteristic value $fsy_1 = fs_1 / 1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b / l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs_1 = (f_{s, \text{jacket}} \cdot A_{s, \text{ten, jacket}} + f_{s, \text{core}} \cdot A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 735.6545$

with $Es_1 = (E_{s, \text{jacket}} \cdot A_{s, \text{ten, jacket}} + E_{s, \text{core}} \cdot A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 200000.00$

$y_2 = 0.0025$
 $sh_2 = 0.008$
 $ft_2 = 872.4558$
 $fy_2 = 727.0465$
 $su_2 = 0.032$

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

Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 1.00$
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,
 For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 727.0465$
 with $Es_2 = (Es_{jacket} * A_{sl,com,jacket} + Es_{core} * A_{sl,com,core}) / A_{sl,com} = 200000.00$
 $y_v = 0.0025$
 $sh_v = 0.008$
 $ft_v = 937.50$
 $fy_v = 781.25$
 $suv = 0.032$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 1.00$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs_{jacket} * A_{sl,mid,jacket} + fs_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 781.25$
 with $Es_v = (Es_{jacket} * A_{sl,mid,jacket} + Es_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$
 $1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.12378842$
 $2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.06860752$
 $v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.04175429$
 and confined core properties:
 $b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 30.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.15295169$
 $2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.08477074$
 $v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.05159117$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y2}$ - LHS eq.(4.5) is not satisfied
 --->
 $v < v_{s,c}$ - RHS eq.(4.5) is satisfied
 --->
 $su (4.8) = 0.16206515$
 $Mu = MRc (4.15) = 7.8817E+008$
 $u = su (4.1) = 6.0907698E-005$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of Shear Strength $V_r = Min(V_{r1}, V_{r2}) = 578810.994$

Calculation of Shear Strength at edge 1, $V_{r1} = 578810.994$
 $V_{r1} = V_n ((22.5.1.1), ACI 318-14)$

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f*Vf'
 where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 192813.976$

= 1 (normal-weight concrete)
Mean concrete strength: $fc' = (fc'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + fc'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 27.76119$, but $fc'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 400.00$
 $d = 536.00$
 $V_u \cdot d / M_u < 1 = 1.00$
 $M_u = 1.1510\text{E}+006$
 $V_u = 9840.634$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 385997.017$
 $V_{s1} = 350811.18$ is calculated for jacket, with:
 $d = 536.00$
 $A_v = 157079.633$
 $f_y = 625.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 35185.838$ is calculated for jacket, with:
 $d = 400.00$
 $A_v = 100530.965$
 $f_y = 525.00$
 $s = 300.00$
 V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
 V_f ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f \leq 750430.726$

Calculation of Shear Strength at edge 2, $V_{r2} = 578810.994$
 $V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ ' where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 192813.976$
= 1 (normal-weight concrete)
Mean concrete strength: $fc' = (fc'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + fc'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 27.76119$, but $fc'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 400.00$
 $d = 536.00$
 $V_u \cdot d / M_u < 1 = 1.00$
 $M_u = 1.1510\text{E}+006$
 $V_u = 9840.632$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 385997.017$
 $V_{s1} = 350811.18$ is calculated for jacket, with:
 $d = 536.00$
 $A_v = 157079.633$
 $f_y = 625.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 35185.838$ is calculated for jacket, with:
 $d = 400.00$
 $A_v = 100530.965$
 $f_y = 525.00$
 $s = 300.00$
 V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
 V_f ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f \leq 750430.726$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1
At local axis: 3

| | |
|--|--|
| Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1 | |
| At Shear local axis: 2 | |
| (Bending local axis: 3) | |
| Section Type: rcjars | |
| Constant Properties | |
| Knowledge Factor, $\phi = 0.87$ | |
| Mean strength values are used for both shear and moment calculations. | |
| Consequently: | |
| Jacket | |
| New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 30.00$ | |
| New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$ | |
| Concrete Elasticity, $E_c = 25742.96$ | |
| Steel Elasticity, $E_s = 200000.00$ | |
| Existing Column | |
| Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$ | |
| Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$ | |
| Concrete Elasticity, $E_c = 23025.204$ | |
| Steel Elasticity, $E_s = 200000.00$ | |
| ##### | |
| 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, $f_s = 1.25 \cdot f_{sm} = 781.25$ | |
| Existing Column | |
| Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 656.25$ | |
| ##### | |
| External Height, $H = 670.00$ | |
| External Width, $W = 400.00$ | |
| Internal Height, $H = 500.00$ | |
| Internal Width, $W = 200.00$ | |
| Cover Thickness, $c = 25.00$ | |
| Mean Confinement Factor overall section = 1.00 | |
| Element Length, $L = 3000.00$ | |
| Secondary Member | |
| Smooth Bars | |
| Ductile Steel | |
| Without Detailing for Earthquake Resistance (including stirrups not closed at 135°) | |
| Longitudinal Bars With Ends Lapped Starting at the End Sections | |
| Adequate Lap Length ($l_o/l_{ou}, \min \geq 1$) | |
| No FRP Wrapping | |
| Stepwise Properties | |
| At local axis: 2 | |
| EDGE -A- | |
| Shear Force, $V_a = -9.0372119E-015$ | |
| EDGE -B- | |
| Shear Force, $V_b = 9.0372119E-015$ | |
| BOTH EDGES | |
| Axial Force, $F = -2309.833$ | |
| Longitudinal Reinforcement Area Distribution (in 2 divisions) | |
| -Tension: $As_t = 709.9999$ | |
| -Compression: $As_c = 1668.186$ | |
| Longitudinal Reinforcement Area Distribution (in 3 divisions) | |
| -Tension: $As_{t,ten} = 911.0619$ | |
| -Compression: $As_{l,com} = 911.0619$ | |
| -Middle: $As_{l,mid} = 556.0619$ | |
| Calculation of Shear Capacity ratio , $V_e/V_r = 0.55914272$ | |
| Member Controlled by Flexure ($V_e/V_r < 1$) | |
| Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 218168.257$ | |

with
 $M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 3.2725\text{E}+008$
 $\mu_{u1+} = 3.2725\text{E}+008$, 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
 $\mu_{u1-} = 3.2725\text{E}+008$, 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
 $M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 3.2725\text{E}+008$
 $\mu_{u2+} = 3.2725\text{E}+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the static loading combination
 $\mu_{u2-} = 3.2725\text{E}+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination
and
 $\pm \nu_{u*ln} = (|V1| + |V2|)/2$
with
 $V1 = -9.0372119\text{E}-015$, is the shear force acting at edge 1 for the static loading combination
 $V2 = 9.0372119\text{E}-015$, is the shear force acting at edge 2 for the static loading combination

Calculation of μ_{u1+}

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

$\phi_u = 0.00010507$
 $\mu_u = 3.2725\text{E}+008$

with full section properties:

$b = 670.00$
 $d = 357.00$
 $d' = 43.00$
 $\nu = 0.0003219$
 $N = 2309.833$
 $f_c = 30.00$
 $\phi_{co} (5A.5, \text{TBDY}) = 0.002$
Final value of ϕ_{cu} : $\phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.0053097$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $\phi_{cu} = 0.0053097$
 $\phi_{we} (5.4c) = 0.00204688$
 $\phi_{ase} ((5.4d), \text{TBDY}) = (\phi_{ase1} * A_{ext} + \phi_{ase2} * A_{int}) / A_{sec} = 0.14776895$
 $\phi_{ase1} = 0.14776895$
 $\phi_{bo_1} = 340.00$
 $\phi_{ho_1} = 610.00$
 $\phi_{bi2_1} = 975400.00$
 $\phi_{ase2} = \text{Max}(\phi_{ase1}, \phi_{ase2}) = 0.14776895$
 $\phi_{bo_2} = 192.00$
 $\phi_{ho_2} = 492.00$
 $\phi_{bi2_2} = 557856.00$

$\phi_{psh,min} * F_{ywe} = \text{Min}(\phi_{psh,x} * F_{ywe}, \phi_{psh,y} * F_{ywe}) = 1.38519$
Expression ((5.4d), TBDY) for $\phi_{psh,min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

 $\phi_{psh,x} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{ps2} * F_{ywe2} = 2.45559$
 $\phi_{ps1} \text{ (external)} = (\phi_{Ash1} * h1 / s1) / A_{sec} = 0.00261799$
 $\phi_{Ash1} = \phi_{Astir_1} * ns_1 = 157.0796$
No stirrups, $ns_1 = 2.00$
 $h1 = 670.00$
 $\phi_{ps2} \text{ (internal)} = (\phi_{Ash2} * h2 / s2) / A_{sec} = 0.00062519$
 $\phi_{Ash2} = \phi_{Astir_2} * ns_2 = 100.531$
No stirrups, $ns_2 = 2.00$
 $h2 = 500.00$

$\phi_{psh,y} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{ps2} * F_{ywe2} = 1.38519$
 $\phi_{ps1} \text{ (external)} = (\phi_{Ash1} * h1 / s1) / A_{sec} = 0.00156298$
 $\phi_{Ash1} = \phi_{Astir_1} * ns_1 = 157.0796$
No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $\phi_{ps2} \text{ (internal)} = (\phi_{Ash2} * h2 / s2) / A_{sec} = 0.00025008$

Ash2 = Astir_2*ns_2 = 100.531
 No stirups, ns_2 = 2.00
 h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 781.25

fywe2 = 656.25

fce = 30.00

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

c = confinement factor = 1.00

y1 = 0.0025

sh1 = 0.008

ft1 = 886.8103

fy1 = 739.0086

su1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

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

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

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

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

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 739.0086

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

y2 = 0.0025

sh2 = 0.008

ft2 = 886.8103

fy2 = 739.0086

su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

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

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

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

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

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 739.0086

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

yv = 0.0025

shv = 0.008

ftv = 895.9746

fyv = 746.6455

suv = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

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

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

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
 For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
 characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

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

with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 746.6455

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

1 = Asl,ten/(b*d)*(fs1/fc) = 0.09382814

2 = Asl,com/(b*d)*(fs2/fc) = 0.09382814

v = Asl,mid/(b*d)*(fsv/fc) = 0.05785932

and confined core properties:

b = 610.00

d = 327.00

$d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 30.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.11251192$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.11251192$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.06938071$
 Case/Assumption: Unconfined full section - Steel rupture
 ' does not satisfy Eq. (4.3)

--->
 $v < v_{s,c}$ - RHS eq.(4.5) is satisfied
 --->

$su (4.9) = 0.1468828$
 $Mu = MRc (4.14) = 3.2725E+008$
 $u = su (4.1) = 0.00010507$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of $Mu1$ -

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

$u = 0.00010507$
 $Mu = 3.2725E+008$

with full section properties:

$b = 670.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.0003219$
 $N = 2309.833$
 $f_c = 30.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0053097$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.0053097$
 $we (5.4c) = 0.00204688$
 $ase ((5.4d), TBDY) = (ase1*A_{ext} + ase2*A_{int})/A_{sec} = 0.14776895$
 $ase1 = 0.14776895$
 $bo_1 = 340.00$
 $ho_1 = 610.00$
 $bi2_1 = 975400.00$
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi2_2 = 557856.00$

$psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.38519$
 Expression ((5.4d), TBDY) for $psh_{min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.45559$
 $ps1 \text{ (external)} = (A_{sh1} * h1 / s1) / A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir_1} * ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 670.00$
 $ps2 \text{ (internal)} = (A_{sh2} * h2 / s2) / A_{sec} = 0.00062519$
 $A_{sh2} = A_{stir_2} * ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 500.00$

$psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.38519$

$$ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00156298$$

$$Ash1 = Astir_1 \cdot ns_1 = 157.0796$$

$$\text{No stirups, } ns_1 = 2.00$$

$$h1 = 400.00$$

$$ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00025008$$

$$Ash2 = Astir_2 \cdot ns_2 = 100.531$$

$$\text{No stirups, } ns_2 = 2.00$$

$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 781.25$$

$$fywe2 = 656.25$$

$$fce = 30.00$$

$$\text{From } ((5A5), \text{TB DY}), \text{TB DY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 886.8103$$

$$fy1 = 739.0086$$

$$su1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/ld = 1.00$$

$$su1 = 0.4 \cdot esu1_{\text{nominal}} ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } esu1_{\text{nominal}} = 0.08,$$

For calculation of $esu1_{\text{nominal}}$ and $y1, sh1, ft1, fy1$, it is considered
characteristic value $fsy1 = fs1/1.2$, from table 5.1, TB DY.

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

$$\text{with } fs1 = (fs_{\text{jacket}} \cdot Asl, \text{ten, jacket} + fs_{\text{core}} \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 739.0086$$

$$\text{with } Es1 = (Es_{\text{jacket}} \cdot Asl, \text{ten, jacket} + Es_{\text{core}} \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$$

$$y2 = 0.0025$$

$$sh2 = 0.008$$

$$ft2 = 886.8103$$

$$fy2 = 739.0086$$

$$su2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/lb, \min = 1.00$$

$$su2 = 0.4 \cdot esu2_{\text{nominal}} ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } esu2_{\text{nominal}} = 0.08,$$

For calculation of $esu2_{\text{nominal}}$ and $y2, sh2, ft2, fy2$, it is considered
characteristic value $fsy2 = fs2/1.2$, from table 5.1, TB DY.

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

$$\text{with } fs2 = (fs_{\text{jacket}} \cdot Asl, \text{com, jacket} + fs_{\text{core}} \cdot Asl, \text{com, core}) / Asl, \text{com} = 739.0086$$

$$\text{with } Es2 = (Es_{\text{jacket}} \cdot Asl, \text{com, jacket} + Es_{\text{core}} \cdot Asl, \text{com, core}) / Asl, \text{com} = 200000.00$$

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 895.9746$$

$$fyv = 746.6455$$

$$suv = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/ld = 1.00$$

$$suv = 0.4 \cdot esuv_{\text{nominal}} ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } esuv_{\text{nominal}} = 0.08,$$

considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TB DY

For calculation of $esuv_{\text{nominal}}$ and yv, shv, ftv, fyv , it is considered
characteristic value $fsyv = fsv/1.2$, from table 5.1, TB DY.

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

$$\text{with } fsv = (fs_{\text{jacket}} \cdot Asl, \text{mid, jacket} + fs_{\text{mid}} \cdot Asl, \text{mid, core}) / Asl, \text{mid} = 746.6455$$

$$\text{with } Esv = (Es_{\text{jacket}} \cdot Asl, \text{mid, jacket} + Es_{\text{mid}} \cdot Asl, \text{mid, core}) / Asl, \text{mid} = 200000.00$$

$$1 = Asl, \text{ten} / (b \cdot d) \cdot (fs1 / fce) = 0.09382814$$

$2 = A_{sl,com}/(b*d)*(f_s2/f_c) = 0.09382814$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.05785932$
 and confined core properties:
 $b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 30.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.11251192$
 $2 = A_{sl,com}/(b*d)*(f_s2/f_c) = 0.11251192$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.06938071$
 Case/Assumption: Unconfined full section - Steel rupture
 ' does not satisfy Eq. (4.3)

--->
 $v < v_{s,c}$ - RHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.1468828$
 $\mu = M_{Rc} (4.14) = 3.2725E+008$
 $u = su (4.1) = 0.00010507$

Calculation of ratio l_b/d

Adequate Lap Length: $l_b/d \geq 1$

Calculation of μ_{2+}

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:
 $u = 0.00010507$
 $\mu = 3.2725E+008$

with full section properties:

$b = 670.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.0003219$
 $N = 2309.833$
 $f_c = 30.00$
 $cc (5A.5, TBDY) = 0.002$
 Final value of μ : $\mu^* = \text{shear_factor} * \text{Max}(\mu_c, cc) = 0.0053097$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $\mu_c = 0.0053097$
 $\mu_{we} (5.4c) = 0.00204688$
 $\mu_{ase} ((5.4d), TBDY) = (\mu_{ase1} * A_{ext} + \mu_{ase2} * A_{int}) / A_{sec} = 0.14776895$
 $\mu_{ase1} = 0.14776895$
 $b_{o_1} = 340.00$
 $h_{o_1} = 610.00$
 $b_{i2_1} = 975400.00$
 $\mu_{ase2} = \text{Max}(\mu_{ase1}, \mu_{ase2}) = 0.14776895$
 $b_{o_2} = 192.00$
 $h_{o_2} = 492.00$
 $b_{i2_2} = 557856.00$

$p_{sh,min} * F_{ywe} = \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.38519$
 Expression ((5.4d), TBDY) for $p_{sh,min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh_x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.45559$
 $ps1 \text{ (external)} = (A_{sh1} * h1 / s1) / A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h1 = 670.00$
 $ps2 \text{ (internal)} = (A_{sh2} * h2 / s2) / A_{sec} = 0.00062519$

Ash2 = Astir_2*ns_2 = 100.531
 No stirups, ns_2 = 2.00
 h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.38519
 ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
 Ash1 = Astir_1*ns_1 = 157.0796
 No stirups, ns_1 = 2.00
 h1 = 400.00
 ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
 Ash2 = Astir_2*ns_2 = 100.531
 No stirups, ns_2 = 2.00
 h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 781.25

fywe2 = 656.25

fce = 30.00

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

c = confinement factor = 1.00

y1 = 0.0025

sh1 = 0.008

ft1 = 886.8103

fy1 = 739.0086

su1 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

lo/lou,min = lb/ld = 1.00

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

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

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

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

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 739.0086

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

y2 = 0.0025

sh2 = 0.008

ft2 = 886.8103

fy2 = 739.0086

su2 = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

lo/lou,min = lb/lb,min = 1.00

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

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

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

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

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 739.0086

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

yv = 0.0025

shv = 0.008

ftv = 895.9746

fyv = 746.6455

suv = 0.032

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

lo/lou,min = lb/ld = 1.00

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

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

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
 For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered

characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 746.6455$
 with $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1}/f_c) = 0.09382814$
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2}/f_c) = 0.09382814$
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv}/f_c) = 0.05785932$

and confined core properties:

$b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $f_{cc} \text{ (5A.2, TBDY)} = 30.00$
 $cc \text{ (5A.5, TBDY)} = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1}/f_c) = 0.11251192$
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2}/f_c) = 0.11251192$
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv}/f_c) = 0.06938071$

Case/Assumption: Unconfined full section - Steel rupture
 ' does not satisfy Eq. (4.3)

---->

$v < v_{s,c}$ - RHS eq.(4.5) is satisfied

---->

$\mu_u \text{ (4.9)} = 0.1468828$
 $\mu_u = M_{Rc} \text{ (4.14)} = 3.2725E+008$
 $u = \mu_u \text{ (4.1)} = 0.00010507$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of μ_{u2} -

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

$u = 0.00010507$
 $\mu_u = 3.2725E+008$

with full section properties:

$b = 670.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.0003219$
 $N = 2309.833$
 $f_c = 30.00$
 $cc \text{ (5A.5, TBDY)} = 0.002$
 Final value of μ_u : $\mu_u^* = \text{shear_factor} \cdot \text{Max}(\mu_u, cc) = 0.0053097$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $\mu_u = 0.0053097$
 $w_e \text{ (5.4c)} = 0.00204688$
 $ase \text{ ((5.4d), TBDY)} = (ase_1 \cdot A_{ext} + ase_2 \cdot A_{int}) / A_{sec} = 0.14776895$
 $ase_1 = 0.14776895$
 $bo_1 = 340.00$
 $ho_1 = 610.00$
 $bi_2_1 = 975400.00$
 $ase_2 = \text{Max}(ase_1, ase_2) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi_2_2 = 557856.00$

$p_{sh,min} \cdot F_{ywe} = \text{Min}(p_{sh,x} \cdot F_{ywe}, p_{sh,y} \cdot F_{ywe}) = 1.38519$

Expression ((5.4d), TBDY) for $p_{sh,min} \cdot F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh,x} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{sh2} \cdot F_{ywe2} = 2.45559$

$$ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00261799$$

$$Ash1 = Astir_1 \cdot ns_1 = 157.0796$$

$$\text{No stirups, } ns_1 = 2.00$$

$$h1 = 670.00$$

$$ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00062519$$

$$Ash2 = Astir_2 \cdot ns_2 = 100.531$$

$$\text{No stirups, } ns_2 = 2.00$$

$$h2 = 500.00$$

$$psh_y \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 1.38519$$

$$ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00156298$$

$$Ash1 = Astir_1 \cdot ns_1 = 157.0796$$

$$\text{No stirups, } ns_1 = 2.00$$

$$h1 = 400.00$$

$$ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00025008$$

$$Ash2 = Astir_2 \cdot ns_2 = 100.531$$

$$\text{No stirups, } ns_2 = 2.00$$

$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 781.25$$

$$fywe2 = 656.25$$

$$fce = 30.00$$

$$\text{From } ((5A5), \text{ TBDY}), \text{ TBDY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 886.8103$$

$$fy1 = 739.0086$$

$$su1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/ld = 1.00$$

$$su1 = 0.4 \cdot esu1_{\text{nominal}} ((5.5), \text{ TBDY}) = 0.032$$

$$\text{From table 5A.1, TBDY: } esu1_{\text{nominal}} = 0.08,$$

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

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

$$\text{with } fs1 = (fs_{\text{jacket}} \cdot Asl, \text{ten, jacket} + fs_{\text{core}} \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 739.0086$$

$$\text{with } Es1 = (Es_{\text{jacket}} \cdot Asl, \text{ten, jacket} + Es_{\text{core}} \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$$

$$y2 = 0.0025$$

$$sh2 = 0.008$$

$$ft2 = 886.8103$$

$$fy2 = 739.0086$$

$$su2 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/lb, \min = 1.00$$

$$su2 = 0.4 \cdot esu2_{\text{nominal}} ((5.5), \text{ TBDY}) = 0.032$$

$$\text{From table 5A.1, TBDY: } esu2_{\text{nominal}} = 0.08,$$

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

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

$$\text{with } fs2 = (fs_{\text{jacket}} \cdot Asl, \text{com, jacket} + fs_{\text{core}} \cdot Asl, \text{com, core}) / Asl, \text{com} = 739.0086$$

$$\text{with } Es2 = (Es_{\text{jacket}} \cdot Asl, \text{com, jacket} + Es_{\text{core}} \cdot Asl, \text{com, core}) / Asl, \text{com} = 200000.00$$

$$yv = 0.0025$$

$$shv = 0.008$$

$$ftv = 895.9746$$

$$fyv = 746.6455$$

$$suv = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$l_o/l_o, \min = l_b/d = 1.00$
 $s_{uv} = 0.4 \cdot e_{suv_nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $e_{suv_nominal} = 0.08$,
 considering characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY
 For calculation of $e_{suv_nominal}$ and y_v , sh_v, ft_v, f_{yv} , it is considered
 characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY.
 y_1 , sh_1, ft_1, f_{y1} , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{sv} = (f_{sj_jacket} \cdot A_{sl, mid, jacket} + f_{s, mid} \cdot A_{sl, mid, core}) / A_{sl, mid} = 746.6455$
 with $E_{sv} = (E_{sj_jacket} \cdot A_{sl, mid, jacket} + E_{s, mid} \cdot A_{sl, mid, core}) / A_{sl, mid} = 200000.00$
 $1 = A_{sl, ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.09382814$
 $2 = A_{sl, com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.09382814$
 $v = A_{sl, mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.05785932$

and confined core properties:

$b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 30.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl, ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.11251192$
 $2 = A_{sl, com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.11251192$
 $v = A_{sl, mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.06938071$

Case/Assumption: Unconfined full section - Steel rupture
 ' does not satisfy Eq. (4.3)

--->

$v < v_{s,c}$ - RHS eq.(4.5) is satisfied

--->

$su (4.9) = 0.1468828$
 $Mu = MRc (4.14) = 3.2725E+008$
 $u = su (4.1) = 0.00010507$

Calculation of ratio l_b/d

Adequate Lap Length: $l_b/d \geq 1$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 390183.487$

Calculation of Shear Strength at edge 1, $V_{r1} = 390183.487$
 $V_{r1} = V_n ((22.5.1.1), ACI 318-14)$

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ '
 where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 180743.977$
 $= 1$ (normal-weight concrete)
 Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot \text{Area}_{jacket} + f'_{c_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 27.76119$, but $f'_c^{0.5} < =$
 8.3 MPa (22.5.3.1, ACI 318-14)
 $p_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 670.00$
 $d = 320.00$
 $V_u \cdot d / Mu < 1 = 0.00$
 $Mu = 6.8565666E-012$
 $V_u = 9.0372119E-015$
 From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 209439.51$
 $V_{s1} = 209439.51$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 625.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17, 10.3.4)
 $V_{s2} = 0.00$ is calculated for jacket, with:
 $d_2 = 160.00$

$$A_v = 100530.965$$

$$f_y = 525.00$$

$$s = 300.00$$

Vs2 is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)

$$V_f ((11-3)-(11.4), \text{ACI 440}) = 0.00$$

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 750430.726$$

Calculation of Shear Strength at edge 2, $V_{r2} = 390183.487$

$$V_{r2} = V_n ((22.5.1.1), \text{ACI 318-14})$$

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw + f*Vf'

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

$$\text{From Table (22.5.5.1), ACI 318-14: } V_c = 180743.977$$

= 1 (normal-weight concrete)

$$\text{Mean concrete strength: } f'_c = (f'_c_{\text{jacket}} * \text{Area}_{\text{jacket}} + f'_c_{\text{core}} * \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 27.76119, \text{ but } f'_c^{0.5} \leq 8.3 \text{ MPa (22.5.3.1, ACI 318-14)}$$

$$p_w = A_s / (b_w * d) = 0.00331157$$

$$A_s (\text{tension reinf.}) = 709.9999$$

$$b_w = 670.00$$

$$d = 320.00$$

$$V_u * d / M_u < 1 = 0.00$$

$$M_u = 2.0256286 \text{E-}011$$

$$V_u = 9.0372119 \text{E-}015$$

$$\text{From (11.5.4.8), ACI 318-14: } V_{s1} + V_{s2} = 209439.51$$

$V_{s1} = 209439.51$ is calculated for jacket, with:

$$d = 320.00$$

$$A_v = 157079.633$$

$$f_y = 625.00$$

$$s = 150.00$$

Vs1 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

Vs2 = 0.00 is calculated for jacket, with:

$$d = 160.00$$

$$A_v = 100530.965$$

$$f_y = 525.00$$

$$s = 300.00$$

Vs2 is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)

$$V_f ((11-3)-(11.4), \text{ACI 440}) = 0.00$$

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 750430.726$$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (b)

Section Type: rcjars

Constant Properties

$$\text{Knowledge Factor, } \phi = 0.87$$

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

$$\text{New material of Secondary Member: Concrete Strength, } f_c = f_{cm} = 30.00$$

$$\text{New material of Secondary Member: Steel Strength, } f_s = f_{sm} = 625.00$$

$$\text{Concrete Elasticity, } E_c = 25742.96$$

$$\text{Steel Elasticity, } E_s = 200000.00$$

Existing Column

$$\text{Existing material of Secondary Member: Concrete Strength, } f_c = f_{cm} = 24.00$$

$$\text{Existing material of Secondary Member: Steel Strength, } f_s = f_{sm} = 525.00$$

$$\text{Concrete Elasticity, } E_c = 23025.204$$

$$\text{Steel Elasticity, } E_s = 200000.00$$

External Height, H = 670.00
 External Width, W = 400.00
 Internal Height, H = 500.00
 Internal Width, W = 200.00
 Cover Thickness, c = 25.00
 Element Length, L = 3000.00
 Secondary Member
 Smooth Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Adequate Lap Length ($l_b/d \geq 1$)
 No FRP Wrapping

Stepwise Properties

Bending Moment, M = 1.6981E+007
 Shear Force, V2 = -2.4489115E-014
 Shear Force, V3 = 18514.856
 Axial Force, F = -9608.729
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: Asl,t = 709.9999
 -Compression: Asl,c = 1668.186
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: Asl,ten = 709.9999
 -Compression: Asl,com = 1266.062
 -Middle: Asl,mid = 402.1239
 Longitudinal External Reinforcement Area Distribution (in 3 divisions)
 -Tension: Asl,ten,jacket = 402.1239
 -Compression: Asl,com,jacket = 804.2477
 -Middle: Asl,mid,jacket = 402.1239
 Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
 -Tension: Asl,ten,core = 307.8761
 -Compression: Asl,com,core = 461.8141
 -Middle: Asl,mid,core = 0.00
 Mean Diameter of Tension Reinforcement, DbL = 15.00

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = \frac{1}{2} u = 0.02277925$
 $u = \frac{1}{2} y + \frac{1}{2} p = 0.02618304$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.00118304$ ((4.29), Biskinis Phd))
 $M_y = 2.9297E+008$
 $L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 917.1471
 From table 10.5, ASCE 41_17: $E_{eff} = 0.3 * E_c * I_g = 7.5708E+013$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$
 $y_{ten} = 5.8262953E-006$
 with $f_y = 625.00$
 $d = 627.00$
 $y = 0.18885675$
 $A = 0.00954705$
 $B = 0.00409845$
 with $p_t = 0.00283094$
 $p_c = 0.00504809$

$p_v = 0.00160336$
 $N = 9608.729$
 $b = 400.00$
 $" = 0.06858054$
 $y_{comp} = 1.7813453E-005$
 with $f_c = 27.76119$
 $E_c = 25742.96$
 $y = 0.18781039$
 $A = 0.00939108$
 $B = 0.0040338$
 with $E_s = 200000.00$

Calculation of ratio I_b/I_d

Adequate Lap Length: $I_b/I_d \geq 1$

- Calculation of p -

From table 10-7: $p = 0.025$

with:

- Condition i occurred
 Beam controlled by flexure: $V_p/V_o \leq 1$
 shear control ratio $V_p/V_o = 0.92480584$
- Transverse Reinforcement: C
- Stirrup Spacing $\leq d/3$
- Low ductility demand, $\gamma < 2$ (table 10-6, ASCE 41-17)
 $= 1.8291976E-005$
- Stirrup Spacing $\leq d/2$
 $d = d_{external} = 627.00$
 $s = s_{external} = 150.00$
- Strength provided by hoops $V_s < 3/4 \times \text{design Shear}$
 $V_s = 421182.855$, already given in calculation of shear control ratio
 design Shear = 18514.856
- $(\rho_t - \rho_c)/\rho_{bal} = -0.3178459$
 $= A_{st}/(b_w \times d) = 0.00283094$
 Tension Reinf Area: $A_{st} = 709.9999$
 $\rho_c = A_{sc}/(b_w \times d) = 0.00665146$
 Compression Reinf Area: $A_{sc} = 1668.186$
- From (B-1), ACI 318-11: $\rho_{bal} = 0.01202003$
 $f_c = (f_{c_jacket} \times \text{Area}_{jacket} + f_{c_core} \times \text{Area}_{core}) / \text{section_area} = 27.76119$
 $f_y = f_{y_jacket_bars} = 625.00$
 From 10.2.7.3, ACI 318-11: $\beta_1 = 0.65$
 From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000 / (87000 + f_y) = c_b/d_t = 0.003 / (0.003 + \gamma) = 0.48979592$
 $\gamma = 0.003125$
- $V / (b_w \times d \times f_c^{0.5}) = 0.16873181$, NOTE: units in I_b & in
 $b_w = 400.00$

End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (b)

Calculation No. 15

beam B1, Floor 1

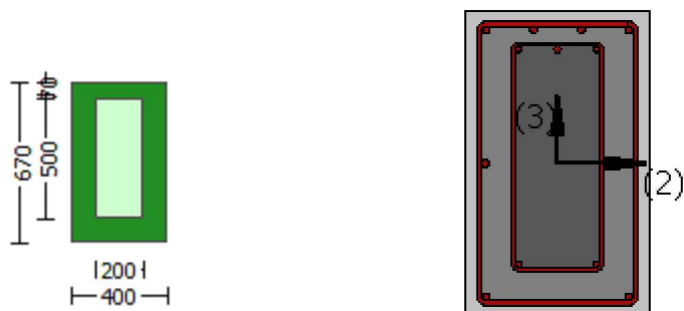
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: End

Local Axis: (3)



Start Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (b)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 0.87$

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, $f_c = f_{c_lower_bound} = 20.00$

New material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 420.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_o/l_{ou,min} = l_b/l_d \geq 1$)

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 9.0425E+006$

Shear Force, $V_a = 1166.41$

EDGE -B-

Bending Moment, $M_b = 1.6981E+007$

Shear Force, $V_b = 18514.856$

BOTH EDGES

Axial Force, $F = -9608.729$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{st} = 709.9999$

-Compression: $A_{sc} = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{st,ten} = 709.9999$

-Compression: $A_{sc,com} = 1266.062$

-Middle: $A_{st,mid} = 402.1239$

Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 15.00$

Existing component: From table 7-7, ASCE 41-17: Final Shear Capacity $V_R = V_n = 403182.72$

V_n ((22.5.1.1), ACI 318-14) = 463428.414

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f^*V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 154630.80$

= 1 (normal-weight concrete)

Mean concrete strength: $f'_c = (f'_{c,jacket} \cdot Area_{jacket} + f'_{c,core} \cdot Area_{core}) / Area_{section} = 18.50746$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$\rho_w = A_s / (b_w \cdot d) = 0.00331157$

A_s (tension reinf.) = 709.9999

$b_w = 400.00$

$d = 536.00$

$V_u \cdot d / M_u < 1 = 0.58442095$

$M_u = 1.6981E+007$

$V_u = 18514.856$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 308797.614$

$V_{s1} = 280648.944$ is calculated for jacket, with:

$d = 536.00$

$A_v = 157079.633$

$f_y = 500.00$

$s = 150.00$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 28148.67$ is calculated for core, with:

$d = 400.00$

$A_v = 100530.965$

$f_y = 420.00$

$s = 300.00$

V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.50$

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

From (11-11), ACI 440: $V_s + V_f \leq 612724.122$

End Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (b)

Calculation No. 16

beam B1, Floor 1

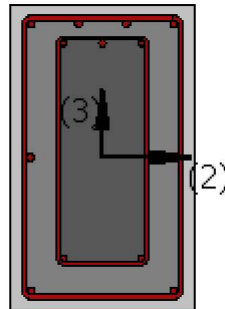
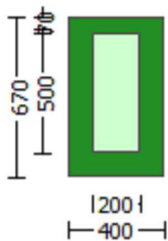
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (ϕ)

Edge: End

Local Axis: (3)



Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\phi = 0.87$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

#####

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, $f_s = 1.25 \cdot f_{sm} = 781.25$

Existing Column

Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 656.25$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$
 Mean Confinement Factor overall section = 1.00
 Element Length, $L = 3000.00$
 Secondary Member
 Smooth Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Adequate Lap Length ($l_o/l_{ou}, \min \geq 1$)
 No FRP Wrapping

Stepwise Properties

At local axis: 3
 EDGE -A-
 Shear Force, $V_a = 9840.634$
 EDGE -B-
 Shear Force, $V_b = 9840.632$
 BOTH EDGES
 Axial Force, $F = -2309.833$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $As_t = 709.9999$
 -Compression: $As_c = 1668.186$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten} = 709.9999$
 -Compression: $As_{c,com} = 1266.062$
 -Middle: $As_{l,mid} = 402.1239$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.92480584$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 535287.788$
 with
 $M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 7.8817E+008$
 $\mu_{u1+} = 4.6479E+008$, 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
 $\mu_{u1-} = 7.8817E+008$, 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
 $M_{pr2} = \max(\mu_{u2+}, \mu_{u2-}) = 7.8817E+008$
 $\mu_{u2+} = 4.6479E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the static loading combination
 $\mu_{u2-} = 7.8817E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination
 and
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$
 with
 $V_1 = 9840.634$, is the shear force acting at edge 1 for the static loading combination
 $V_2 = 9840.632$, is the shear force acting at edge 2 for the static loading combination

Calculation of μ_{u1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 5.6369735E-005$
 $\mu_u = 4.6479E+008$

with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.000307$
 $N = 2309.833$

$f_c = 30.00$
 $c_o (5A.5, TBDY) = 0.002$
 Final value of c_u : $c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.0053097$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $c_u = 0.0053097$
 $w_e (5.4c) = 0.00204688$
 $a_{se} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$
 $a_{se1} = 0.14776895$
 $b_o_1 = 340.00$
 $h_o_1 = 610.00$
 $b_{i2_1} = 975400.00$
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$
 $b_o_2 = 192.00$
 $h_o_2 = 492.00$
 $b_{i2_2} = 557856.00$
 $p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.38519$
 Expression ((5.4d), TBDY) for $p_{sh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.45559$
 $p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h_1 = 670.00$
 $p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirrups, $n_{s_2} = 2.00$
 $h_2 = 500.00$

$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.38519$
 $p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h_1 = 400.00$
 $p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirrups, $n_{s_2} = 2.00$
 $h_2 = 200.00$

$A_{sec} = 268000.00$
 $s_1 = 150.00$
 $s_2 = 300.00$
 $f_{ywe1} = 781.25$
 $f_{ywe2} = 656.25$
 $f_{ce} = 30.00$

From ((5.A5), TBDY), TBDY: $c_c = 0.002$
 $c = \text{confinement factor} = 1.00$

$y_1 = 0.0025$
 $sh_1 = 0.008$
 $ft_1 = 872.4558$
 $fy_1 = 727.0465$
 $su_1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$l_o / l_{ou, \min} = l_b / l_d = 1.00$

$su_1 = 0.4 * esu_{1, \text{nominal}} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esu_{1, \text{nominal}} = 0.08$

For calculation of $esu_{1, \text{nominal}}$ and y_1, sh_1, ft_1, fy_1 , it is considered
 characteristic value $fsy_1 = fs_1 / 1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b / l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs_1 = (f_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + f_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 727.0465$

with $Es_1 = (E_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + E_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 200000.00$

$y_2 = 0.0025$
 $sh_2 = 0.008$
 $ft_2 = 882.7854$
 $fy_2 = 735.6545$

```

su2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lo,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 735.6545
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 937.50
fyv = 781.25
suv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lo,min = lb/ld = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 781.25
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06860752
2 = Asl,com/(b*d)*(fs2/fc) = 0.12378842
v = Asl,mid/(b*d)*(fsv/fc) = 0.04175429
and confined core properties:
b = 340.00
d = 597.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.08477074
2 = Asl,com/(b*d)*(fs2/fc) = 0.15295169
v = Asl,mid/(b*d)*(fsv/fc) = 0.05159117
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.09460844
Mu = MRc (4.14) = 4.6479E+008
u = su (4.1) = 5.6369735E-005

```

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

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

u = 6.0907698E-005

Mu = 7.8817E+008

with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.000307$
 $N = 2309.833$
 $f_c = 30.00$
 $\phi (5A.5, TBDY) = 0.002$
 Final value of ϕ : $\phi^* = \text{shear_factor} * \text{Max}(\phi, \phi_c) = 0.0053097$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $\phi = 0.0053097$
 $\phi (5.4c) = 0.00204688$
 $\phi (5.4d), TBDY = (\phi_1 * A_{ext} + \phi_2 * A_{int}) / A_{sec} = 0.14776895$
 $\phi_1 = 0.14776895$
 $b_o_1 = 340.00$
 $h_o_1 = 610.00$
 $b_{i2_1} = 975400.00$
 $\phi_2 = \text{Max}(\phi_1, \phi_2) = 0.14776895$
 $b_o_2 = 192.00$
 $h_o_2 = 492.00$
 $b_{i2_2} = 557856.00$
 $\phi_{sh, \min} * F_{ywe} = \text{Min}(\phi_{sh, x} * F_{ywe}, \phi_{sh, y} * F_{ywe}) = 1.38519$
 Expression ((5.4d), TBDY) for $\phi_{sh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$\phi_{sh, x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.45559$
 $\phi_{sh1} \text{ (external)} = (\phi_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$
 $\phi_{sh1} = \text{Astir}_1 * n_{s1} = 157.0796$
 No stirrups, $n_{s1} = 2.00$
 $h_1 = 670.00$
 $\phi_{sh2} \text{ (internal)} = (\phi_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$
 $\phi_{sh2} = \text{Astir}_2 * n_{s2} = 100.531$
 No stirrups, $n_{s2} = 2.00$
 $h_2 = 500.00$

$\phi_{sh, y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.38519$
 $\phi_{sh1} \text{ (external)} = (\phi_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$
 $\phi_{sh1} = \text{Astir}_1 * n_{s1} = 157.0796$
 No stirrups, $n_{s1} = 2.00$
 $h_1 = 400.00$
 $\phi_{sh2} \text{ (internal)} = (\phi_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$
 $\phi_{sh2} = \text{Astir}_2 * n_{s2} = 100.531$
 No stirrups, $n_{s2} = 2.00$
 $h_2 = 200.00$

$A_{sec} = 268000.00$
 $s_1 = 150.00$
 $s_2 = 300.00$
 $f_{ywe1} = 781.25$
 $f_{ywe2} = 656.25$
 $f_{ce} = 30.00$
 From ((5.A5), TBDY), TBDY: $\phi_c = 0.002$
 $\phi_c = \text{confinement factor} = 1.00$
 $y_1 = 0.0025$
 $sh_1 = 0.008$
 $ft_1 = 882.7854$
 $fy_1 = 735.6545$
 $su_1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $l_o / l_{ou, \min} = l_b / l_d = 1.00$
 $su_1 = 0.4 * esu_1_{\text{nominal}} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_1_{\text{nominal}} = 0.08$,
 For calculation of esu_1_{nominal} and y_1 , sh_1 , ft_1 , fy_1 , it is considered
 characteristic value $fsy_1 = fs_1 / 1.2$, from table 5.1, TBDY.
 y_1 , sh_1 , ft_1 , fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b / l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_1 = (fs_{\text{jacket}} * A_{sl, \text{ten, jacket}} + fs_{\text{core}} * A_{sl, \text{ten, core}}) / A_{sl, \text{ten}} = 735.6545$

```

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 872.4558
fy2 = 727.0465
su2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 727.0465
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 937.50
fyv = 781.25
suv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 781.25
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.12378842
2 = Asl,com/(b*d)*(fs2/fc) = 0.06860752
v = Asl,mid/(b*d)*(fsv/fc) = 0.04175429
and confined core properties:
b = 340.00
d = 597.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.15295169
2 = Asl,com/(b*d)*(fs2/fc) = 0.08477074
v = Asl,mid/(b*d)*(fsv/fc) = 0.05159117
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is not satisfied
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.8) = 0.16206515
Mu = MRc (4.15) = 7.8817E+008
u = su (4.1) = 6.0907698E-005

```

Calculation of ratio lb/lb

Adequate Lap Length: lb/lb >= 1

Calculation of Mu2+

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

$$u = 5.6369735E-005$$

$$\mu = 4.6479E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.000307$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$\alpha (5A.5, \text{TBDY}) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.0053097$$

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

$$\text{From (5.4b), TBDY: } \phi_u = 0.0053097$$

$$\phi_{ue} (5.4c) = 0.00204688$$

$$\phi_{se} ((5.4d), \text{TBDY}) = (\phi_{se1} * A_{ext} + \phi_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$\phi_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$\phi_{se2} = \text{Max}(\phi_{se1}, \phi_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$\phi_{sh,min} * F_{ywe} = \text{Min}(\phi_{sh,x} * F_{ywe}, \phi_{sh,y} * F_{ywe}) = 1.38519$$

Expression ((5.4d), TBDY) for $\phi_{sh,min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\phi_{sh,x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.45559$$

$$\phi_{sh1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$\phi_{sh2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$\phi_{sh,y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.38519$$

$$\phi_{sh1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$\phi_{sh2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 656.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_c = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y_1 = 0.0025$$

$$sh_1 = 0.008$$

$$ft_1 = 872.4558$$

$$fy_1 = 727.0465$$

$$su_1 = 0.032$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

```

lo/lou,min = lb/d = 1.00
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 727.0465
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 882.7854
fy2 = 735.6545
su2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 735.6545
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 937.50
fyv = 781.25
suv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 781.25
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06860752
2 = Asl,com/(b*d)*(fs2/fc) = 0.12378842
v = Asl,mid/(b*d)*(fsv/fc) = 0.04175429
and confined core properties:
b = 340.00
d = 597.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.08477074
2 = Asl,com/(b*d)*(fs2/fc) = 0.15295169
v = Asl,mid/(b*d)*(fsv/fc) = 0.05159117
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.09460844
Mu = MRc (4.14) = 4.6479E+008
u = su (4.1) = 5.6369735E-005

```

Calculation of ratio lb/d

Adequate Lap Length: lb/d >= 1

Calculation of Mu2-

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

$$\mu = 6.0907698E-005$$

$$Mu = 7.8817E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.000307$$

$$N = 2309.833$$

$$f_c = 30.00$$

$$cc \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } \mu: \mu^* = \text{shear_factor} * \text{Max}(\mu, cc) = 0.0053097$$

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

$$\text{From (5.4b), TBDY: } \mu = 0.0053097$$

$$\mu_e \text{ (5.4c)} = 0.00204688$$

$$ase \text{ ((5.4d), TBDY)} = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$$

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

$$ho_1 = 610.00$$

$$bi2_1 = 975400.00$$

$$ase2 = \text{Max}(ase1, ase2) = 0.14776895$$

$$bo_2 = 192.00$$

$$ho_2 = 492.00$$

$$bi2_2 = 557856.00$$

$$psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.38519$$

Expression ((5.4d), TBDY) for $psh_{min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.45559$$

$$ps1 \text{ (external)} = (Ash1 * h1 / s1) / A_{sec} = 0.00261799$$

$$Ash1 = Astir_1 * ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h1 = 670.00$$

$$ps2 \text{ (internal)} = (Ash2 * h2 / s2) / A_{sec} = 0.00062519$$

$$Ash2 = Astir_2 * ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h2 = 500.00$$

$$psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.38519$$

$$ps1 \text{ (external)} = (Ash1 * h1 / s1) / A_{sec} = 0.00156298$$

$$Ash1 = Astir_1 * ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h1 = 400.00$$

$$ps2 \text{ (internal)} = (Ash2 * h2 / s2) / A_{sec} = 0.00025008$$

$$Ash2 = Astir_2 * ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fy_{we1} = 781.25$$

$$fy_{we2} = 656.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TBDY), TBDY: } cc = 0.002$$

$$c = \text{confinement factor} = 1.00$$

$$y1 = 0.0025$$

$$sh1 = 0.008$$

$$ft1 = 882.7854$$

```

fy1 = 735.6545
su1 = 0.032
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb = 1.00
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 735.6545
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0025
sh2 = 0.008
ft2 = 872.4558
fy2 = 727.0465
su2 = 0.032
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 1.00
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 727.0465
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 937.50
fyv = 781.25
suv = 0.032
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb = 1.00
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 781.25
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.12378842
2 = Asl,com/(b*d)*(fs2/fc) = 0.06860752
v = Asl,mid/(b*d)*(fsv/fc) = 0.04175429
and confined core properties:
b = 340.00
d = 597.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.15295169
    2 = Asl,com/(b*d)*(fs2/fc) = 0.08477074
    v = Asl,mid/(b*d)*(fsv/fc) = 0.05159117
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
---->
v < vs,y2 - LHS eq.(4.5) is not satisfied
---->
v < vs,c - RHS eq.(4.5) is satisfied
---->
su (4.8) = 0.16206515

```

$$\begin{aligned}\mu &= MRC(4.15) = 7.8817E+008 \\ u &= su(4.1) = 6.0907698E-005\end{aligned}$$

Calculation of ratio l_b/l_d

Adequate Lap Length: $l_b/l_d \geq 1$

Calculation of Shear Strength $V_r = \min(V_{r1}, V_{r2}) = 578810.994$

Calculation of Shear Strength at edge 1, $V_{r1} = 578810.994$

$V_{r1} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f^*V_f$ ' where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 192813.976$
 $= 1$ (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_c_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f'_c_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 27.76119$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 400.00$
 $d = 536.00$
 $V_u \cdot d / \mu < 1 = 1.00$
 $\mu = 1.1510E+006$
 $V_u = 9840.634$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 385997.017$
 $V_{s1} = 350811.18$ is calculated for jacket, with:
 $d = 536.00$
 $A_v = 157079.633$
 $f_y = 625.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17, 10.3.4)
 $V_{s2} = 35185.838$ is calculated for jacket, with:
 $d_2 = 400.00$
 $A_v = 100530.965$
 $f_y = 525.00$
 $s = 300.00$
 V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17, 10.3.4)
 $2(1-s/d) = 0.50$
 V_f ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f \leq 750430.726$

Calculation of Shear Strength at edge 2, $V_{r2} = 578810.994$

$V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f^*V_f$ ' where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 192813.976$
 $= 1$ (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_c_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f'_c_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 27.76119$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 400.00$
 $d = 536.00$
 $V_u \cdot d / \mu < 1 = 1.00$
 $\mu = 1.1510E+006$
 $V_u = 9840.632$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 385997.017$
 $V_{s1} = 350811.18$ is calculated for jacket, with:
 $d = 536.00$

Av = 157079.633

fy = 625.00

s = 150.00

Vs1 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

Vs2 = 35185.838 is calculated for jacket, with:

d = 400.00

Av = 100530.965

fy = 525.00

s = 300.00

Vs2 has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.50$

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

From (11-11), ACI 440: $Vs + Vf \leq 750430.726$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 2

(Bending local axis: 3)

Section Type: rcjars

Constant Properties

Knowledge Factor, = 0.87

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$

Concrete Elasticity, $E_c = 23025.204$

Steel Elasticity, $E_s = 200000.00$

#####

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, $f_s = 1.25 \cdot f_{sm} = 781.25$

Existing Column

Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 656.25$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Adequate Lap Length ($l_o/l_{ou}, \min > 1$)

No FRP Wrapping

Stepwise Properties

At local axis: 2

EDGE -A-
 Shear Force, $V_a = -9.0372119\text{E-}015$
 EDGE -B-
 Shear Force, $V_b = 9.0372119\text{E-}015$
 BOTH EDGES
 Axial Force, $F = -2309.833$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $A_{st} = 709.9999$
 -Compression: $A_{sc} = 1668.186$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $A_{st,ten} = 911.0619$
 -Compression: $A_{sc,com} = 911.0619$
 -Middle: $A_{sl,mid} = 556.0619$

 Calculation of Shear Capacity ratio , $V_e/V_r = 0.55914272$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 218168.257$
 with
 $M_{pr1} = \text{Max}(Mu_{1+} , Mu_{1-}) = 3.2725\text{E+}008$
 $Mu_{1+} = 3.2725\text{E+}008$, 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
 $Mu_{1-} = 3.2725\text{E+}008$, 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
 $M_{pr2} = \text{Max}(Mu_{2+} , Mu_{2-}) = 3.2725\text{E+}008$
 $Mu_{2+} = 3.2725\text{E+}008$, 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
 $Mu_{2-} = 3.2725\text{E+}008$, 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
 and
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$
 with
 $V_1 = -9.0372119\text{E-}015$, is the shear force acting at edge 1 for the the static loading combination
 $V_2 = 9.0372119\text{E-}015$, is the shear force acting at edge 2 for the the static loading combination

 Calculation of Mu_{1+}

 Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 0.00010507$
 $M_u = 3.2725\text{E+}008$

with full section properties:

$b = 670.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.0003219$
 $N = 2309.833$
 $f_c = 30.00$
 ϕ_c (5A.5, TBDY) = 0.002
 Final value of ϕ_u : $\phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.0053097$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $\phi_u = 0.0053097$
 w_e (5.4c) = 0.00204688
 a_{se} ((5.4d), TBDY) = $(a_{se1} \cdot A_{ext} + a_{se2} \cdot A_{int})/A_{sec} = 0.14776895$
 $a_{se1} = 0.14776895$
 $bo_1 = 340.00$
 $ho_1 = 610.00$
 $bi2_1 = 975400.00$
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi2_2 = 557856.00$

$psh,min*Fywe = \text{Min}(psh,x*Fywe, psh,y*Fywe) = 1.38519$
 Expression ((5.4d), TBDY) for $psh,min*Fywe$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh_x*Fywe = psh1*Fywe1 + ps2*Fywe2 = 2.45559$
 $ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00261799$
 $Ash1 = Astir_1*ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 670.00$
 $ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00062519$
 $Ash2 = Astir_2*ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 500.00$

$psh_y*Fywe = psh1*Fywe1 + ps2*Fywe2 = 1.38519$
 $ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00156298$
 $Ash1 = Astir_1*ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00025008$
 $Ash2 = Astir_2*ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

$Asec = 268000.00$
 $s1 = 150.00$
 $s2 = 300.00$
 $fywe1 = 781.25$
 $fywe2 = 656.25$
 $fce = 30.00$

From ((5.A5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$

$y1 = 0.0025$
 $sh1 = 0.008$
 $ft1 = 886.8103$
 $fy1 = 739.0086$
 $su1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/ld = 1.00$

$su1 = 0.4*esu1_nominal \text{ ((5.5), TBDY)} = 0.032$

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

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

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

with $fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 739.0086$

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

$y2 = 0.0025$
 $sh2 = 0.008$
 $ft2 = 886.8103$
 $fy2 = 739.0086$
 $su2 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lou,min = lb/lb,min = 1.00$

$su2 = 0.4*esu2_nominal \text{ ((5.5), TBDY)} = 0.032$

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

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

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

with $fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 739.0086$

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

$yv = 0.0025$
 $shv = 0.008$
 $ftv = 895.9746$


```

fyv = 746.6455
suv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lo,min = lb/ld = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fsjacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 746.6455
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09382814
2 = Asl,com/(b*d)*(fs2/fc) = 0.09382814
v = Asl,mid/(b*d)*(fsv/fc) = 0.05785932
and confined core properties:
b = 610.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11251192
2 = Asl,com/(b*d)*(fs2/fc) = 0.11251192
v = Asl,mid/(b*d)*(fsv/fc) = 0.06938071
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.9) = 0.1468828
Mu = MRc (4.14) = 3.2725E+008
u = su (4.1) = 0.00010507

```

Calculation of ratio lb/ld

Adequate Lap Length: lb/ld >= 1

Calculation of Mu1-

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

```

u = 0.00010507
Mu = 3.2725E+008

```

with full section properties:

```

b = 670.00
d = 357.00
d' = 43.00
v = 0.0003219
N = 2309.833
fc = 30.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.0053097
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0053097
we (5.4c) = 0.00204688
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.14776895
ase1 = 0.14776895
bo_1 = 340.00
ho_1 = 610.00

```

$bi2_1 = 975400.00$
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi2_2 = 557856.00$
 $psh, \min * Fywe = \text{Min}(psh, x * Fywe, psh, y * Fywe) = 1.38519$
 Expression ((5.4d), TBDY) for $psh, \min * Fywe$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh_x * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 2.45559$
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.00261799$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 670.00$
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00062519$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 500.00$

$psh_y * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 1.38519$
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.00156298$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00025008$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

$Asec = 268000.00$
 $s1 = 150.00$
 $s2 = 300.00$
 $fywe1 = 781.25$
 $fywe2 = 656.25$
 $fce = 30.00$

From ((5.A5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$

$y1 = 0.0025$
 $sh1 = 0.008$
 $ft1 = 886.8103$
 $fy1 = 739.0086$
 $su1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lou, \min = lb/l_d = 1.00$

$su1 = 0.4 * esu1_nominal \text{ ((5.5), TBDY)} = 0.032$

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

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

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

with $fs1 = (fs, \text{jacket} * Asl, \text{ten, jacket} + fs, \text{core} * Asl, \text{ten, core}) / Asl, \text{ten} = 739.0086$

with $Es1 = (Es, \text{jacket} * Asl, \text{ten, jacket} + Es, \text{core} * Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$

$y2 = 0.0025$
 $sh2 = 0.008$
 $ft2 = 886.8103$
 $fy2 = 739.0086$
 $su2 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lou, \min = lb/l_b, \min = 1.00$

$su2 = 0.4 * esu2_nominal \text{ ((5.5), TBDY)} = 0.032$

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

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

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

```

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 739.0086
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 895.9746
fyv = 746.6455
suv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 746.6455
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09382814
2 = Asl,com/(b*d)*(fs2/fc) = 0.09382814
v = Asl,mid/(b*d)*(fsv/fc) = 0.05785932
and confined core properties:
b = 610.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11251192
2 = Asl,com/(b*d)*(fs2/fc) = 0.11251192
v = Asl,mid/(b*d)*(fsv/fc) = 0.06938071
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.9) = 0.1468828
Mu = MRc (4.14) = 3.2725E+008
u = su (4.1) = 0.00010507

```

Calculation of ratio lb/d

Adequate Lap Length: lb/d >= 1

Calculation of Mu2+

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

```

u = 0.00010507
Mu = 3.2725E+008

```

with full section properties:

```

b = 670.00
d = 357.00
d' = 43.00
v = 0.0003219
N = 2309.833
fc = 30.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.0053097
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0053097

```

$w_e (5.4c) = 0.00204688$
 $ase ((5.4d), TBDY) = (ase1 \cdot A_{ext} + ase2 \cdot A_{int}) / A_{sec} = 0.14776895$
 $ase1 = 0.14776895$
 $bo_1 = 340.00$
 $ho_1 = 610.00$
 $bi2_1 = 975400.00$
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi2_2 = 557856.00$

$psh, min \cdot F_{ywe} = \text{Min}(psh, x \cdot F_{ywe}, psh, y \cdot F_{ywe}) = 1.38519$
 Expression ((5.4d), TBDY) for $psh, min \cdot F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh, x \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 2.45559$
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / A_{sec} = 0.00261799$
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 670.00$
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / A_{sec} = 0.00062519$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 500.00$

$psh, y \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 1.38519$
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / A_{sec} = 0.00156298$
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / A_{sec} = 0.00025008$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

$A_{sec} = 268000.00$

$s1 = 150.00$

$s2 = 300.00$

$fywe1 = 781.25$

$fywe2 = 656.25$

$f_{ce} = 30.00$

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

$c = \text{confinement factor} = 1.00$

$y1 = 0.0025$

$sh1 = 0.008$

$ft1 = 886.8103$

$fy1 = 739.0086$

$su1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$lo/lo, min = lb/ld = 1.00$

$su1 = 0.4 \cdot esu1_nominal ((5.5), TBDY) = 0.032$

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

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

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

with $fs1 = (fs, jacket \cdot A_{sl, ten, jacket} + fs, core \cdot A_{sl, ten, core}) / A_{sl, ten} = 739.0086$

with $Es1 = (Es, jacket \cdot A_{sl, ten, jacket} + Es, core \cdot A_{sl, ten, core}) / A_{sl, ten} = 200000.00$

$y2 = 0.0025$

$sh2 = 0.008$

$ft2 = 886.8103$

$fy2 = 739.0086$

$su2 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$lo/lo, min = lb/lb, min = 1.00$

$su_2 = 0.4 \cdot esu_{2_nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{2_nominal} = 0.08$,
 For calculation of $esu_{2_nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = (fs_{jacket} \cdot Asl_{com,jacket} + fs_{core} \cdot Asl_{com,core}) / Asl_{com} = 739.0086$
 with $Es_2 = (Es_{jacket} \cdot Asl_{com,jacket} + Es_{core} \cdot Asl_{com,core}) / Asl_{com} = 200000.00$
 $y_v = 0.0025$
 $sh_v = 0.008$
 $ft_v = 895.9746$
 $fy_v = 746.6455$
 $suv = 0.032$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lo_{u,min} = lb/ld = 1.00$
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsyv = fs_v/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fsyv = fs_v/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_v = (fs_{jacket} \cdot Asl_{mid,jacket} + fs_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 746.6455$
 with $Es_v = (Es_{jacket} \cdot Asl_{mid,jacket} + Es_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 200000.00$
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.09382814$
 $2 = Asl_{com} / (b \cdot d) \cdot (fs_2 / fc) = 0.09382814$
 $v = Asl_{mid} / (b \cdot d) \cdot (fs_v / fc) = 0.05785932$
 and confined core properties:
 $b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 30.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.11251192$
 $2 = Asl_{com} / (b \cdot d) \cdot (fs_2 / fc) = 0.11251192$
 $v = Asl_{mid} / (b \cdot d) \cdot (fs_v / fc) = 0.06938071$
 Case/Assumption: Unconfined full section - Steel rupture
 ' does not satisfy Eq. (4.3)
 --->
 $v < v_{s,c}$ - RHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.1468828$
 $Mu = MRc (4.14) = 3.2725E+008$
 $u = su (4.1) = 0.00010507$

Calculation of ratio lb/ld

Adequate Lap Length: $lb/ld \geq 1$

Calculation of Mu_2 -

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

$u = 0.00010507$
 $Mu = 3.2725E+008$

with full section properties:

$b = 670.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.0003219$
 $N = 2309.833$

$f_c = 30.00$
 $c_o (5A.5, TBDY) = 0.002$
 Final value of c_u : $c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.0053097$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $c_u = 0.0053097$
 $w_e (5.4c) = 0.00204688$
 $a_{se} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$
 $a_{se1} = 0.14776895$
 $b_o_1 = 340.00$
 $h_o_1 = 610.00$
 $b_{i2_1} = 975400.00$
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$
 $b_o_2 = 192.00$
 $h_o_2 = 492.00$
 $b_{i2_2} = 557856.00$
 $p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.38519$
 Expression ((5.4d), TBDY) for $p_{sh, \min} * F_{ywe}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.45559$
 $p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h_1 = 670.00$
 $p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirrups, $n_{s_2} = 2.00$
 $h_2 = 500.00$

$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.38519$
 $p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h_1 = 400.00$
 $p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirrups, $n_{s_2} = 2.00$
 $h_2 = 200.00$

$A_{sec} = 268000.00$
 $s_1 = 150.00$
 $s_2 = 300.00$
 $f_{ywe1} = 781.25$
 $f_{ywe2} = 656.25$
 $f_{ce} = 30.00$

From ((5.A5), TBDY), TBDY: $c_c = 0.002$
 $c = \text{confinement factor} = 1.00$

$y_1 = 0.0025$
 $sh_1 = 0.008$
 $ft_1 = 886.8103$
 $fy_1 = 739.0086$
 $su_1 = 0.032$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$l_o / l_{ou, \min} = l_b / l_d = 1.00$

$su_1 = 0.4 * esu_{1_nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esu_{1_nominal} = 0.08$,

For calculation of $esu_{1_nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered
 characteristic value $fsy_1 = fs_1 / 1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b / l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs_1 = (f_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + f_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 739.0086$

with $Es_1 = (E_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + E_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 200000.00$

$y_2 = 0.0025$
 $sh_2 = 0.008$
 $ft_2 = 886.8103$
 $fy_2 = 739.0086$

```

su2 = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 1.00
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 739.0086
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0025
shv = 0.008
ftv = 895.9746
fyv = 746.6455
suv = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 1.00
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 746.6455
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09382814
2 = Asl,com/(b*d)*(fs2/fc) = 0.09382814
v = Asl,mid/(b*d)*(fsv/fc) = 0.05785932
and confined core properties:
b = 610.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 30.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.11251192
2 = Asl,com/(b*d)*(fs2/fc) = 0.11251192
v = Asl,mid/(b*d)*(fsv/fc) = 0.06938071
Case/Assumption: Unconfined full section - Steel rupture
' does not satisfy Eq. (4.3)
--->
v < vs,c - RHS eq.(4.5) is satisfied
--->
su (4.9) = 0.1468828
Mu = MRc (4.14) = 3.2725E+008
u = su (4.1) = 0.00010507

```

Calculation of ratio lb/lb

Adequate Lap Length: lb/lb >= 1

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 390183.487$

Calculation of Shear Strength at edge 1, $V_{r1} = 390183.487$
 $V_{r1} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f*Vf'
 where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 180743.977$
 $= 1$ (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot Area_jacket + f'_{c_core} \cdot Area_core) / Area_section = 27.76119$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 670.00$
 $d = 320.00$
 $V_u \cdot d / M_u < 1 = 0.00$
 $M_u = 6.8565666E-012$
 $V_u = 9.0372119E-015$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 209439.51$
 $V_{s1} = 209439.51$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 625.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 0.00$ is calculated for jacket, with:
 $d/2 = 160.00$
 $A_v = 100530.965$
 $f_y = 525.00$
 $s = 300.00$
 V_{s2} is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)
 V_f ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f \leq 750430.726$

Calculation of Shear Strength at edge 2, $V_{r2} = 390183.487$
 $V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 180743.977$
 $= 1$ (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot Area_jacket + f'_{c_core} \cdot Area_core) / Area_section = 27.76119$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 670.00$
 $d = 320.00$
 $V_u \cdot d / M_u < 1 = 0.00$
 $M_u = 2.0256286E-011$
 $V_u = 9.0372119E-015$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 209439.51$
 $V_{s1} = 209439.51$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 625.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 0.00$ is calculated for jacket, with:
 $d/2 = 160.00$
 $A_v = 100530.965$
 $f_y = 525.00$
 $s = 300.00$
 V_{s2} is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)
 V_f ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f \leq 750430.726$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 3
Integration Section: (b)
Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 0.87$
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, $f_c = f_{cm} = 30.00$
New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 625.00$
Concrete Elasticity, $E_c = 25742.96$
Steel Elasticity, $E_s = 200000.00$
Existing Column
Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 24.00$
Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 525.00$
Concrete Elasticity, $E_c = 23025.204$
Steel Elasticity, $E_s = 200000.00$
External Height, $H = 670.00$
External Width, $W = 400.00$
Internal Height, $H = 500.00$
Internal Width, $W = 200.00$
Cover Thickness, $c = 25.00$
Element Length, $L = 3000.00$
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length ($l_b/d \geq 1$)
No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 4.4683392E-011$
Shear Force, $V_2 = -2.4489115E-014$
Shear Force, $V_3 = 18514.856$
Axial Force, $F = -9608.729$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $As_t = 709.9999$
-Compression: $As_c = 1668.186$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $As_{t,ten} = 911.0619$
-Compression: $As_{l,com} = 911.0619$
-Middle: $As_{l,mid} = 556.0619$
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: $As_{t,ten,jacket} = 603.1858$
-Compression: $As_{l,com,jacket} = 603.1858$
-Middle: $As_{l,mid,jacket} = 402.1239$
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
-Tension: $As_{t,ten,core} = 307.8761$
-Compression: $As_{l,com,core} = 307.8761$
-Middle: $As_{l,mid,core} = 153.938$
Mean Diameter of Tension Reinforcement, $Db_L = 15.20$

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_{R} = \gamma \cdot u = 0.02097574$
 $u = \gamma + p = 0.02411005$

- Calculation of γ -

$y = (M_y * L_s / 3) / E_{eff} = 0.00411005 \text{ ((4.29), Biskinis Phd)}$
 $M_y = 2.1288E+008$
 $L_s = M/V \text{ (with } L_s > 0.1 * L \text{ and } L_s < 2 * L) = 1500.00$
 From table 10.5, ASCE 41_17: $E_{eff} = 0.3 * E_c * I_g = 2.5898E+013$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$
 $y_{ten} = 1.0755102E-005$
 with $f_y = 625.00$
 $d = 357.00$
 $y = 0.22825315$
 $A = 0.01001045$
 $B = 0.0056379$
 with $p_t = 0.00380895$
 $p_c = 0.00380895$
 $p_v = 0.00232477$
 $N = 9608.729$
 $b = 670.00$
 $" = 0.12044818$
 $y_{comp} = 2.5830452E-005$
 with $f_c = 27.76119$
 $E_c = 25742.96$
 $y = 0.22747572$
 $A = 0.00984691$
 $B = 0.00557012$
 with $E_s = 200000.00$

Calculation of ratio I_b/I_d

Adequate Lap Length: $I_b/I_d \geq 1$

- Calculation of p -

From table 10-7: $p = 0.02$

with:

- Condition i occurred
- Beam controlled by flexure: $V_p/V_o \leq 1$
- shear control ratio $V_p/V_o = 0.55914272$
- Transverse Reinforcement: NC
- Stirrup Spacing $> d/3$
- Low ductility demand, $\phi / y < 2$ (table 10-6, ASCE 41-17)
 $= -4.4850417E-023$
- Stirrup Spacing $\leq d/2$
 $d = d_{external} = 357.00$
 $s = s_{external} = 150.00$
- Strength provided by hoops $V_s < 3/4 * \text{design Shear}$
 $V_s = 237588.18$, already given in calculation of shear control ratio
 design Shear = $2.4489115E-014$
- $(\phi - \phi') / \phi_{bal} = -0.33327376$
 $= A_{st} / (b_w * d) = 0.00296835$
 Tension Reinf Area: $A_{st} = 709.9999$
 $\phi' = A_{sc} / (b_w * d) = 0.00697431$
 Compression Reinf Area: $A_{sc} = 1668.186$
- From (B-1), ACI 318-11: $\phi_{bal} = 0.01202003$
 $f_c = (f_{c_jacket} * \text{Area}_{jacket} + f_{c_core} * \text{Area}_{core}) / \text{section_area} = 27.76119$
 $f_y = f_{y_jacket_bars} = 625.00$
 From 10.2.7.3, ACI 318-11: $\phi = 0.65$
 From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000 / (87000 + f_y) = c_b/d_t = 0.003 / (0.003 + y) = 0.48979592$
 $y = 0.003125$
- $V / (b_w * d * f_c^{0.5}) = 2.3400990E-019$, NOTE: units in lb & in

bw = 670.00

End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (b)
