

Detailed Member Calculations

Units: N&mm

Regulation: ASCE 41-17

Calculation No. 1

column C1, Floor 1

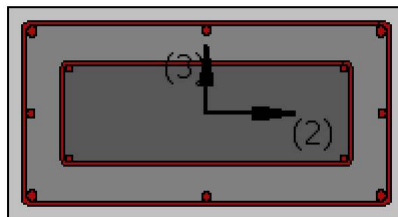
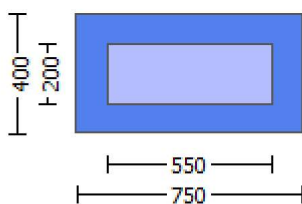
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity VR_d

Edge: Start

Local Axis: (2)



Start Of Calculation of Shear Capacity for element: column JC1 of floor 1

At local axis: 2

Integration Section: (a)

Section Type: rcjrs

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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, $f_c = f_{c_lower_bound} = 25.00$

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

Concrete Elasticity, $E_c = 26999.444$
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, $f_s = f_{s_lower_bound} = 400.00$
Concrete Elasticity, $E_c = 21019.039$
Steel Elasticity, $E_s = 200000.00$

Note: Especially for the calculation of μ_y for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, $f_c = f_{cm} = 33.00$
New material: Steel Strength, $f_s = f_{sm} = 555.56$
Existing Column
Existing material: Concrete Strength, $f_c = f_{cm} = 20.00$
Existing material: Steel Strength, $f_s = f_{sm} = 444.44$

External Height, $H = 400.00$
External Width, $W = 750.00$
Internal Height, $H = 200.00$
Internal Width, $W = 550.00$
Cover Thickness, $c = 25.00$
Element Length, $L = 3000.00$
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with $l_o/l_{ou,min} = l_b/l_d = 0.30$
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, $M_a = -1.1684E+007$
Shear Force, $V_a = -3386.997$
EDGE -B-
Bending Moment, $M_b = 1.5146E+006$
Shear Force, $V_b = 3386.997$
BOTH EDGES
Axial Force, $F = -16097.112$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{sl,t} = 0.00$
-Compression: $A_{sl,c} = 2676.637$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{sl,ten} = 1137.257$
-Compression: $A_{sl,com} = 1137.257$
-Middle: $A_{sl,mid} = 402.1239$
Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 16.80$

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = V_n = 683363.019$
 V_n ((10.3), ASCE 41-17) = $k_n \cdot V_{CoI} = 683363.019$
 $V_{CoI} = 683363.019$
 $k_n = 1.00$
displacement_ductility_demand = 0.02573457

NOTE: In expression (10-3) ' $V_s = A_v \cdot f_y \cdot d/s$ ' is replaced by ' $V_s + f' \cdot V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_c_jacket \cdot Area_jacket + f'_c_core \cdot Area_core) / Area_section = 21.70$, but $f'_c^{0.5} \leq 8.3$
MPa (22.5.3.1, ACI 318-14)

$M/Vd = 4.00$
 $\mu_u = 1.1684E+007$
 $V_u = 3386.997$
 $d = 0.8 \cdot h = 600.00$
 $N_u = 16097.112$
 $A_g = 300000.00$
 From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} = 542012.697$
 where:
 $V_{s1} = 471238.898$ is calculated for jacket, with:
 $d = 600.00$
 $A_v = 157079.633$
 $f_y = 500.00$
 $s = 100.00$
 V_{s1} is multiplied by $Col1 = 1.00$
 $s/d = 0.16666667$
 $V_{s2} = 70773.799$ is calculated for core, with:
 $d = 440.00$
 $A_v = 100530.965$
 $f_y = 400.00$
 $s = 250.00$
 V_{s2} is multiplied by $Col2 = 1.00$
 $s/d = 0.56818182$
 $V_f ((11-3)-(11.4), ACI 440) = 0.00$
 From (11-11), ACI 440: $V_s + V_f \leq 742690.493$
 $b_w = 400.00$

displacement ductility demand is calculated as δ_u / y

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

From analysis, chord rotation $\theta_r = 6.8121454E-005$
 $y = (M_y \cdot L_s / 3) / E_{eff} = 0.00264708$ ((4.29), Biskinis Phd))
 $M_y = 2.5076E+008$
 $L_s = M/V$ (with $L_s > 0.1 \cdot L$ and $L_s < 2 \cdot L$) = 3449.669
 From table 10.5, ASCE 41_17: $E_{eff} = factor \cdot E_c \cdot I_g = 1.0893E+014$
 $factor = 0.30$
 $A_g = 300000.00$
 Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot Area_{jacket} + f'_{c_core} \cdot Area_{core}) / Area_{section} = 28.23333$
 $N = 16097.112$
 $E_c \cdot I_g = E_{c_jacket} \cdot I_{g_jacket} + E_{c_core} \cdot I_{g_core} = 3.6310E+014$

Calculation of Yielding Moment M_y

Calculation of δ_u and M_y according to Annex 7 -

$y = \min(y_{ten}, y_{com})$
 $y_{ten} = 2.6761016E-006$
 with ((10.1), ASCE 41-17) $f_y = \min(f_y, 1.25 \cdot f_y \cdot (I_b / I_d)^{2/3}) = 296.8915$
 $d = 707.00$
 $y = 0.21540464$
 $A = 0.00965649$
 $B = 0.00521193$
 with $p_t = 0.00402142$
 $p_c = 0.00402142$
 $p_v = 0.00142194$
 $N = 16097.112$
 $b = 400.00$
 $\lambda = 0.06082037$
 $y_{comp} = 1.4664753E-005$
 with $f_c = 33.00$
 $E_c = 26999.444$
 $y = 0.21219612$

A = 0.00933541
B = 0.00502021
with Es = 200000.00

Calculation of ratio I_b/I_d

Inadequate Lap Length with $I_b/I_d = 0.30$

End Of Calculation of Shear Capacity for element: column JC1 of floor 1

At local axis: 2

Integration Section: (a)

Calculation No. 2

column C1, Floor 1

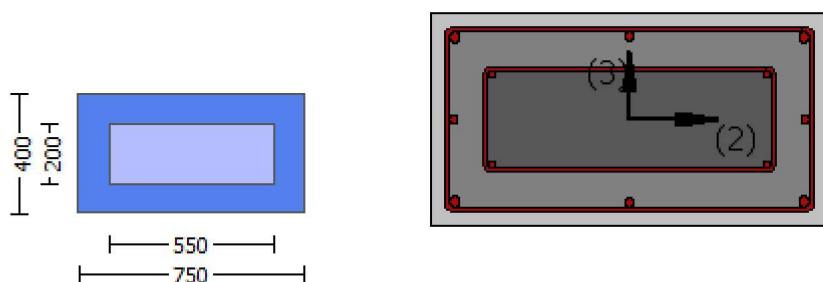
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (ϕ)

Edge: Start

Local Axis: (2)



Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjrs

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 33.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.56$

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$
 Existing Column
 Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 20.00$
 Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 444.44$
 Concrete Elasticity, $E_c = 21019.039$
 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, $f_s = 1.25 \cdot f_{sm} = 694.45$
 Existing Column
 Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 555.55$
 #####
 External Height, $H = 400.00$
 External Width, $W = 750.00$
 Internal Height, $H = 200.00$
 Internal Width, $W = 550.00$
 Cover Thickness, $c = 25.00$
 Mean Confinement Factor overall section = 1.00
 Element Length, $L = 3000.00$
 Secondary Member
 Ribbed Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Inadequate Lap Length with $l_o/l_{ou,min} = 0.30$
 No FRP Wrapping

Stepwise Properties

At local axis: 3
 EDGE -A-
 Shear Force, $V_a = -1.3927229E-031$
 EDGE -B-
 Shear Force, $V_b = 1.3927229E-031$
 BOTH EDGES
 Axial Force, $F = -11016.808$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $A_{sl,t} = 0.00$
 -Compression: $A_{sl,c} = 2676.637$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $A_{sl,ten} = 1137.257$
 -Compression: $A_{sl,com} = 1137.257$
 -Middle: $A_{sl,mid} = 402.1239$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.19160863$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 115015.186$
 with
 $M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 1.7252E+008$
 $\mu_{u1+} = 1.7252E+008$, 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
 $\mu_{u1-} = 1.7252E+008$, 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
 $M_{pr2} = \max(\mu_{u2+}, \mu_{u2-}) = 1.7252E+008$
 $\mu_{u2+} = 1.7252E+008$, 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
 $\mu_{u2-} = 1.7252E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment
 direction which is defined for the the static loading combination

Calculation of μ_{u1+}

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

$$u = 1.7214953E-005$$

$$\mu = 1.7252E+008$$

with full section properties:

$$b = 750.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00124684$$

$$N = 11016.808$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.0052143$$

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

$$\text{From (5.4b), TBDY: } \phi_u = 0.0052143$$

$$\phi_{ue} (5.4c) = 0.00183676$$

$$\alpha_e ((5.4d), \text{TBDY}) = (\alpha e_1 * A_{ext} + \alpha e_2 * A_{int}) / A_{sec} = 0.12601038$$

$$\alpha e_1 = 0.12601038$$

$$b_{o_1} = 690.00$$

$$h_{o_1} = 340.00$$

$$b_{i2_1} = 1.1834E+006$$

$$\alpha e_2 = \text{Max}(\alpha e_1, \alpha e_2) = 0.12601038$$

$$b_{o_2} = 542.00$$

$$h_{o_2} = 192.00$$

$$b_{i2_2} = 661256.00$$

$$\phi_{sh,min} * F_{ywe} = \text{Min}(\phi_{sh,x} * F_{ywe}, \phi_{sh,y} * F_{ywe}) = 1.60339$$

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)

$$\phi_{sh,x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.60339$$

$$\phi_{sh1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.0020944$$

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

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

$$h_1 = 400.00$$

$$\phi_{sh2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00026808$$

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

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

$$h_2 = 200.00$$

$$\phi_{sh,y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 3.13667$$

$$\phi_{sh1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00392699$$

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

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

$$h_1 = 750.00$$

$$\phi_{sh2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00073723$$

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

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

$$h_2 = 550.00$$

$$A_{sec} = 300000.00$$

$$s_1 = 100.00$$

$$s_2 = 250.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 555.55$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 441.5397$$

$$fy_1 = 367.9498$$

$$su_1 = 0.00512$$

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

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Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 367.9498
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 441.5397
fy2 = 367.9498
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 367.9498
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04735912
2 = Asl,com/(b*d)*(fs2/fc) = 0.04735912
v = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05619999
2 = Asl,com/(b*d)*(fs2/fc) = 0.05619999
v = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.16690234
Mu = MRc (4.14) = 1.7252E+008
u = su (4.1) = 1.7214953E-005

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Calculation of ratio lb/ld

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of μ_1 -

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

$$\mu = 1.7214953E-005$$

$$\mu_1 = 1.7252E+008$$

with full section properties:

$$b = 750.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00124684$$

$$N = 11016.808$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu_1: \mu_1^* = \text{shear_factor} * \text{Max}(\mu_1, c_o) = 0.0052143$$

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

$$\text{From (5.4b), TBDY: } \mu_1 = 0.0052143$$

$$\mu_1 \text{ (5.4c)} = 0.00183676$$

$$a_{se} \text{ ((5.4d), TBDY)} = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.12601038$$

$$a_{se1} = 0.12601038$$

$$b_{o_1} = 690.00$$

$$h_{o_1} = 340.00$$

$$b_{i2_1} = 1.1834E+006$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.12601038$$

$$b_{o_2} = 542.00$$

$$h_{o_2} = 192.00$$

$$b_{i2_2} = 661256.00$$

$$p_{sh,min} * F_{ywe} = \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.60339$$

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)

$$p_{sh,x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.60339$$

$$p_{sh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.0020944$$

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

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

$$h_1 = 400.00$$

$$p_{sh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00026808$$

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

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

$$h_2 = 200.00$$

$$p_{sh,y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 3.13667$$

$$p_{sh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00392699$$

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

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

$$h_1 = 750.00$$

$$p_{sh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00073723$$

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

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

$$h_2 = 550.00$$

$$A_{sec} = 300000.00$$

$$s_1 = 100.00$$

$$s_2 = 250.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 555.55$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$


```

ft1 = 441.5397
fy1 = 367.9498
su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 367.9498
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 441.5397
fy2 = 367.9498
su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.30
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 367.9498
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04735912
2 = Asl,com/(b*d)*(fs2/fc) = 0.04735912
v = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.05619999
    2 = Asl,com/(b*d)*(fs2/fc) = 0.05619999
    v = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.16690234
Mu = MRc (4.14) = 1.7252E+008

```

$$u = s_u(4.1) = 1.7214953E-005$$

Calculation of ratio I_b/I_d

Inadequate Lap Length with $I_b/I_d = 0.30$

Calculation of μ_{2+}

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

$$u = 1.7214953E-005$$

$$\mu = 1.7252E+008$$

with full section properties:

$$b = 750.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00124684$$

$$N = 11016.808$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu: \mu^* = \text{shear_factor} * \text{Max}(\mu, \alpha) = 0.0052143$$

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

$$\text{From (5.4b), TBDY: } \mu = 0.0052143$$

$$\mu_e(5.4c) = 0.00183676$$

$$\alpha_e((5.4d), TBDY) = (\alpha_1 * A_{ext} + \alpha_2 * A_{int}) / A_{sec} = 0.12601038$$

$$\alpha_1 = 0.12601038$$

$$b_{o1} = 690.00$$

$$h_{o1} = 340.00$$

$$b_{i21} = 1.1834E+006$$

$$\alpha_2 = \text{Max}(\alpha_1, \alpha_2) = 0.12601038$$

$$b_{o2} = 542.00$$

$$h_{o2} = 192.00$$

$$b_{i22} = 661256.00$$

$$\mu_{sh,min} * F_{ywe} = \text{Min}(\mu_{sh,x} * F_{ywe}, \mu_{sh,y} * F_{ywe}) = 1.60339$$

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)

$$\mu_{sh,x} * F_{ywe} = \mu_{sh1} * F_{ywe1} + \mu_{sh2} * F_{ywe2} = 1.60339$$

$$\mu_{sh1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.0020944$$

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

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

$$h_1 = 400.00$$

$$\mu_{sh2}(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00026808$$

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

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

$$h_2 = 200.00$$

$$\mu_{sh,y} * F_{ywe} = \mu_{sh1} * F_{ywe1} + \mu_{sh2} * F_{ywe2} = 3.13667$$

$$\mu_{sh1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00392699$$

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

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

$$h_1 = 750.00$$

$$\mu_{sh2}(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00073723$$

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

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

$$h_2 = 550.00$$

$$A_{sec} = 300000.00$$

$$s_1 = 100.00$$

$$s_2 = 250.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 555.55$$

```

fce = 33.00
From ((5A.5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 441.5397
fy1 = 367.9498
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 367.9498
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 441.5397
fy2 = 367.9498
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 367.9498
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04735912
2 = Asl,com/(b*d)*(fs2/fc) = 0.04735912
v = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05619999
2 = Asl,com/(b*d)*(fs2/fc) = 0.05619999
v = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)

```

```

--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.16690234
Mu = MRc (4.14) = 1.7252E+008
u = su (4.1) = 1.7214953E-005
-----

Calculation of ratio lb/ld
-----

Inadequate Lap Length with lb/ld = 0.30
-----

Calculation of Mu2-
-----

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 1.7214953E-005
Mu = 1.7252E+008
-----

with full section properties:
b = 750.00
d = 357.00
d' = 43.00
v = 0.00124684
N = 11016.808
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.0052143
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0052143
we (5.4c) = 0.00183676
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
bi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
bi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.60339
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 = 1.60339
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.13667
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00
-----

```

```

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00
From ((5A.5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 441.5397
fy1 = 367.9498
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 367.9498
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 441.5397
fy2 = 367.9498
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 367.9498
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.30
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04735912
2 = Asl,com/(b*d)*(fs2/fc) = 0.04735912
v = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00

```

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.05619999$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.05619999$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.02100943$$

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

--->

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

--->

$$s_u(4.9) = 0.16690234$$

$$M_u = M_{Rc}(4.14) = 1.7252E+008$$

$$u = s_u(4.1) = 1.7214953E-005$$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Shear Strength $V_r = \min(V_{r1}, V_{r2}) = 600261.003$

Calculation of Shear Strength at edge 1, $V_{r1} = 600261.003$

$V_{r1} = V_{Col}((10.3), ASCE 41-17) = k_{nl} * V_{Col0}$

$V_{Col0} = 600261.003$

$k_{nl} = 1$ (zero step-static loading)

NOTE: In expression (10-3) ' $V_s = A_v * f_y * d / s$ ' is replaced by ' $V_{s+} + f * V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

$= 1$ (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c,jacket} * Area_{jacket} + f'_{c,core} * Area_{core}) / Area_{section} = 28.23333$, but $f_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$M/Vd = 2.00$

$M_u = 1.0002017E-011$

$V_u = 1.3927229E-031$

$d = 0.8 * h = 320.00$

$N_u = 11016.808$

$A_g = 300000.00$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} = 279254.914$

where:

$V_{s1} = 279254.914$ is calculated for jacket, with:

$d = 320.00$

$A_v = 157079.633$

$f_y = 555.56$

$s = 100.00$

V_{s1} is multiplied by $Col1 = 1.00$

$s/d = 0.3125$

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

$d = 160.00$

$A_v = 100530.965$

$f_y = 444.44$

$s = 250.00$

V_{s2} is multiplied by $Col2 = 0.00$

$s/d = 1.5625$

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

From (11-11), ACI 440: $V_s + V_f \leq 847147.582$

$bw = 750.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 600261.003$

$V_{r2} = V_{Col}((10.3), ASCE 41-17) = k_{nl} * V_{Col0}$

$V_{Col0} = 600261.003$

$k_{nl} = 1$ (zero step-static loading)

NOTE: In expression (10-3) ' $V_s = A_v * f_y * d / s$ ' is replaced by ' $V_{s+} + f * V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

= 1 (normal-weight concrete)
Mean concrete strength: $f_c' = (f_c'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f_c'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 28.23333$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $M/Vd = 2.00$
 $\mu_u = 1.0002017\text{E}-011$
 $V_u = 1.3927229\text{E}-031$
 $d = 0.8 \cdot h = 320.00$
 $N_u = 11016.808$
 $A_g = 300000.00$
From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} = 279254.914$
where:
 $V_{s1} = 279254.914$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 555.56$
 $s = 100.00$
 V_{s1} is multiplied by $\text{Col1} = 1.00$
 $s/d = 0.3125$
 $V_{s2} = 0.00$ is calculated for core, with:
 $d = 160.00$
 $A_v = 100530.965$
 $f_y = 444.44$
 $s = 250.00$
 V_{s2} is multiplied by $\text{Col2} = 0.00$
 $s/d = 1.5625$
 $V_f ((11-3)-(11.4), \text{ACI } 440) = 0.00$
From (11-11), ACI 440: $V_s + V_f \leq 847147.582$
 $b_w = 750.00$

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

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

Constant Properties

Knowledge Factor, $\phi = 1.00$
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.56$
Concrete Elasticity, $E_c = 26999.444$
Steel Elasticity, $E_s = 200000.00$
Existing Column
Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 20.00$
Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 444.44$
Concrete Elasticity, $E_c = 21019.039$
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, $f_s = 1.25 \cdot f_{sm} = 694.45$
Existing Column
Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 555.55$

External Height, $H = 400.00$
External Width, $W = 750.00$

Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with $l_o/l_{o,min}$ = 0.30
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, V_a = -3.9443045E-031
EDGE -B-
Shear Force, V_b = 3.9443045E-031
BOTH EDGES
Axial Force, F = -11016.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{sl,t}$ = 0.00
-Compression: $A_{sl,c}$ = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{sl,ten}$ = 1137.257
-Compression: $A_{sl,com}$ = 1137.257
-Middle: $A_{sl,mid}$ = 402.1239

Calculation of Shear Capacity ratio , V_e/V_r = 0.25537128
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 235770.47$
with
 $M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 3.5366\text{E}+008$
 $\mu_{u1+} = 3.5366\text{E}+008$, 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
 $\mu_{u1-} = 3.5366\text{E}+008$, 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
 $M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 3.5366\text{E}+008$
 $\mu_{u2+} = 3.5366\text{E}+008$, 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
 $\mu_{u2-} = 3.5366\text{E}+008$, 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

Calculation of μ_{u1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 8.5738376\text{E}-006$
 $M_u = 3.5366\text{E}+008$

with full section properties:

b = 400.00
d = 707.00
d' = 43.00
 $\nu = 0.00118049$
N = 11016.808
 $f_c = 33.00$
 ϕ_o (5A.5, TBDY) = 0.002
Final value of ϕ_u : $\phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.0052143$

The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $c_u = 0.0052143$
 we (5.4c) = 0.00183676
 $ase((5.4d), TBDY) = (ase1 \cdot A_{ext} + ase2 \cdot A_{int}) / A_{sec} = 0.12601038$
 $ase1 = 0.12601038$
 $bo_1 = 690.00$
 $ho_1 = 340.00$
 $bi2_1 = 1.1834E+006$
 $ase2 = \text{Max}(ase1, ase2) = 0.12601038$
 $bo_2 = 542.00$
 $ho_2 = 192.00$
 $bi2_2 = 661256.00$
 $psh, \min \cdot F_{ywe} = \text{Min}(psh, x \cdot F_{ywe}, psh, y \cdot F_{ywe}) = 1.60339$
 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)

$psh, x \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 1.60339$
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / A_{sec} = 0.0020944$
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / A_{sec} = 0.00026808$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

$psh, y \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 3.13667$
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / A_{sec} = 0.00392699$
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 750.00$
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / A_{sec} = 0.00073723$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 550.00$

$A_{sec} = 300000.00$
 $s1 = 100.00$
 $s2 = 250.00$
 $fywe1 = 694.45$
 $fywe2 = 555.55$
 $f_{ce} = 33.00$

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

$y1 = 0.00140044$
 $sh1 = 0.0044814$

$ft1 = 441.5397$

$fy1 = 367.9498$

$su1 = 0.00512$

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

$lo/lo, \min = lb/ld = 0.30$

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

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 $fs1 = (fs, \text{jacket} \cdot A_{sl, \text{ten, jacket}} + fs, \text{core} \cdot A_{sl, \text{ten, core}}) / A_{sl, \text{ten}} = 367.9498$

with $Es1 = (Es, \text{jacket} \cdot A_{sl, \text{ten, jacket}} + Es, \text{core} \cdot A_{sl, \text{ten, core}}) / A_{sl, \text{ten}} = 200000.00$

$y2 = 0.00140044$

$sh2 = 0.0044814$

$ft2 = 441.5397$

$fy2 = 367.9498$

$su2 = 0.00512$

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

Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.30$
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$
 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 $fs_2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 367.9498$
 with $Es_2 = (Es_{jacket} * A_{sl,com,jacket} + Es_{core} * A_{sl,com,core}) / A_{sl,com} = 200000.00$
 $y_v = 0.00140044$
 $sh_v = 0.0044814$
 $ft_v = 466.8167$
 $fy_v = 389.0139$
 $su_v = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.30$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsv = fs_v/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fsv = fs_v/1.2$, 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 $fs_v = (fs_{jacket} * A_{sl,mid,jacket} + fs_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 389.0139$
 with $Es_v = (Es_{jacket} * A_{sl,mid,jacket} + Es_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$
 $1 = A_{sl,ten} / (b * d) * (fs_1 / f_c) = 0.04483877$
 $2 = A_{sl,com} / (b * d) * (fs_2 / f_c) = 0.04483877$
 $v = A_{sl,mid} / (b * d) * (fs_v / f_c) = 0.01676222$
 and confined core properties:
 $b = 340.00$
 $d = 677.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten} / (b * d) * (fs_1 / f_c) = 0.05508907$
 $2 = A_{sl,com} / (b * d) * (fs_2 / f_c) = 0.05508907$
 $v = A_{sl,mid} / (b * d) * (fs_v / f_c) = 0.02059413$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.1553529$
 $Mu = MRc (4.14) = 3.5366E+008$
 $u = su (4.1) = 8.5738376E-006$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Mu_1 -

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

$$u = 8.5738376E-006$$

$$Mu = 3.5366E+008$$

with full section properties:

$$b = 400.00$$

$$d = 707.00$$

$$d' = 43.00$$

$v = 0.00118049$
 $N = 11016.808$
 $fc = 33.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = shear_factor * Max(cu, cc) = 0.0052143$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.0052143$
 $we (5.4c) = 0.00183676$
 $ase ((5.4d), TBDY) = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.12601038$
 $ase1 = 0.12601038$
 $bo_1 = 690.00$
 $ho_1 = 340.00$
 $bi2_1 = 1.1834E+006$
 $ase2 = Max(ase1, ase2) = 0.12601038$
 $bo_2 = 542.00$
 $ho_2 = 192.00$
 $bi2_2 = 661256.00$
 $psh, min * F_{ywe} = Min(psh, x * F_{ywe}, psh, y * F_{ywe}) = 1.60339$
 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)

$psh, x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.60339$
 $ps1 (external) = (Ash1 * h1 / s1) / A_{sec} = 0.0020944$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 (internal) = (Ash2 * h2 / s2) / A_{sec} = 0.00026808$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

$psh, y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 3.13667$
 $ps1 (external) = (Ash1 * h1 / s1) / A_{sec} = 0.00392699$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 750.00$
 $ps2 (internal) = (Ash2 * h2 / s2) / A_{sec} = 0.00073723$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 550.00$

$A_{sec} = 300000.00$
 $s1 = 100.00$
 $s2 = 250.00$
 $fywe1 = 694.45$
 $fywe2 = 555.55$
 $f_{ce} = 33.00$

From ((5.A.5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$
 $y1 = 0.00140044$
 $sh1 = 0.0044814$
 $ft1 = 441.5397$
 $fy1 = 367.9498$
 $su1 = 0.00512$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lo_{u,min} = lb/ld = 0.30$
 $su1 = 0.4 * esu1_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu1_nominal = 0.08$,
 For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs1 / 1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs1 = (fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 367.9498$
 with $Es1 = (Es_{jacket} * A_{sl,ten,jacket} + Es_{core} * A_{sl,ten,core}) / A_{sl,ten} = 200000.00$
 $y2 = 0.00140044$
 $sh2 = 0.0044814$

```

ft2 = 441.5397
fy2 = 367.9498
su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.30
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 367.9498
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
    yv = 0.00140044
    shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb = 0.30
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.04483877
    2 = Asl,com/(b*d)*(fs2/fc) = 0.04483877
    v = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.05508907
    2 = Asl,com/(b*d)*(fs2/fc) = 0.05508907
    v = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
---->
v < vs,y2 - LHS eq.(4.5) is satisfied
---->
su (4.9) = 0.1553529
Mu = MRc (4.14) = 3.5366E+008
u = su (4.1) = 8.5738376E-006

```

Calculation of ratio lb/lb

Inadequate Lap Length with lb/lb = 0.30

Calculation of Mu2+

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

u = 8.5738376E-006
Mu = 3.5366E+008

with full section properties:

$$b = 400.00$$

$$d = 707.00$$

$$d' = 43.00$$

$$v = 0.00118049$$

$$N = 11016.808$$

$$f_c = 33.00$$

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

$$\text{Final value of } \alpha: \alpha^* = \text{shear_factor} * \text{Max}(\alpha, \alpha_c) = 0.0052143$$

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

$$\text{From (5.4b), TB DY: } \alpha = 0.0052143$$

$$\alpha_e (5.4c) = 0.00183676$$

$$\alpha_e ((5.4d), \text{TB DY}) = (\alpha_{e1} * A_{ext} + \alpha_{e2} * A_{int}) / A_{sec} = 0.12601038$$

$$\alpha_{e1} = 0.12601038$$

$$b_{o1} = 690.00$$

$$h_{o1} = 340.00$$

$$b_{i21} = 1.1834E+006$$

$$\alpha_{e2} = \text{Max}(\alpha_{e1}, \alpha_{e2}) = 0.12601038$$

$$b_{o2} = 542.00$$

$$h_{o2} = 192.00$$

$$b_{i22} = 661256.00$$

$$psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.60339$$

Expression ((5.4d), TB DY) 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)

$$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.60339$$

$$ps1 \text{ (external)} = (A_{sh1} * h1 / s1) / A_{sec} = 0.0020944$$

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

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

$$h1 = 400.00$$

$$ps2 \text{ (internal)} = (A_{sh2} * h2 / s2) / A_{sec} = 0.00026808$$

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

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

$$h2 = 200.00$$

$$psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 3.13667$$

$$ps1 \text{ (external)} = (A_{sh1} * h1 / s1) / A_{sec} = 0.00392699$$

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

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

$$h1 = 750.00$$

$$ps2 \text{ (internal)} = (A_{sh2} * h2 / s2) / A_{sec} = 0.00073723$$

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

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

$$h2 = 550.00$$

$$A_{sec} = 300000.00$$

$$s1 = 100.00$$

$$s2 = 250.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 555.55$$

$$f_{ce} = 33.00$$

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

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

$$y1 = 0.00140044$$

$$sh1 = 0.0044814$$

$$ft1 = 441.5397$$

$$fy1 = 367.9498$$

$$su1 = 0.00512$$

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

and also multiplied by the shear_factor according to 15.7.1.4, with

$$\text{Shear_factor} = 1.00$$

$$l_o / l_{ou, \min} = l_b / l_d = 0.30$$

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

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.

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 $fs_1 = (fs_{jacket} \cdot A_{sl,ten,jacket} + fs_{core} \cdot A_{sl,ten,core}) / A_{sl,ten} = 367.9498$
 with $Es_1 = (Es_{jacket} \cdot A_{sl,ten,jacket} + Es_{core} \cdot A_{sl,ten,core}) / A_{sl,ten} = 200000.00$
 $y_2 = 0.00140044$
 $sh_2 = 0.0044814$
 $ft_2 = 441.5397$
 $fy_2 = 367.9498$
 $su_2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.30$
 $su_2 = 0.4 \cdot esu_{2,nominal} ((5.5), TBDY) = 0.032$
 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 $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = (fs_{jacket} \cdot A_{sl,com,jacket} + fs_{core} \cdot A_{sl,com,core}) / A_{sl,com} = 367.9498$
 with $Es_2 = (Es_{jacket} \cdot A_{sl,com,jacket} + Es_{core} \cdot A_{sl,com,core}) / A_{sl,com} = 200000.00$
 $y_v = 0.00140044$
 $sh_v = 0.0044814$
 $ft_v = 466.8167$
 $fy_v = 389.0139$
 $su_v = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.30$
 $su_v = 0.4 \cdot esu_{v,nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{v,nominal} = 0.08$,
 considering characteristic value $fsy_v = fs_v/1.2$, 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 $fsy_v = fs_v/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_v = (fs_{jacket} \cdot A_{sl,mid,jacket} + fs_{mid} \cdot A_{sl,mid,core}) / A_{sl,mid} = 389.0139$
 with $Es_v = (Es_{jacket} \cdot A_{sl,mid,jacket} + Es_{mid} \cdot A_{sl,mid,core}) / A_{sl,mid} = 200000.00$
 $1 = A_{sl,ten} / (b \cdot d) \cdot (fs_1 / f_c) = 0.04483877$
 $2 = A_{sl,com} / (b \cdot d) \cdot (fs_2 / f_c) = 0.04483877$
 $v = A_{sl,mid} / (b \cdot d) \cdot (fs_v / f_c) = 0.01676222$
 and confined core properties:
 $b = 340.00$
 $d = 677.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten} / (b \cdot d) \cdot (fs_1 / f_c) = 0.05508907$
 $2 = A_{sl,com} / (b \cdot d) \cdot (fs_2 / f_c) = 0.05508907$
 $v = A_{sl,mid} / (b \cdot d) \cdot (fs_v / f_c) = 0.02059413$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y_2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.1553529$
 $Mu = MR_c (4.14) = 3.5366E+008$
 $u = u (4.1) = 8.5738376E-006$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Mu_2 -

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

$$u = 8.5738376E-006$$

$$\mu = 3.5366E+008$$

with full section properties:

$$b = 400.00$$

$$d = 707.00$$

$$d' = 43.00$$

$$v = 0.00118049$$

$$N = 11016.808$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.0052143$$

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

$$\text{From (5.4b), TBDY: } \phi_u = 0.0052143$$

$$\phi_{ue} \text{ (5.4c)} = 0.00183676$$

$$\phi_{ase} \text{ ((5.4d), TBDY)} = (\phi_{ase1} * A_{ext} + \phi_{ase2} * A_{int}) / A_{sec} = 0.12601038$$

$$\phi_{ase1} = 0.12601038$$

$$b_{o_1} = 690.00$$

$$h_{o_1} = 340.00$$

$$b_{i2_1} = 1.1834E+006$$

$$\phi_{ase2} = \text{Max}(\phi_{ase1}, \phi_{ase2}) = 0.12601038$$

$$b_{o_2} = 542.00$$

$$h_{o_2} = 192.00$$

$$b_{i2_2} = 661256.00$$

$$\phi_{psh,min} * F_{ywe} = \text{Min}(\phi_{psh,x} * F_{ywe}, \phi_{psh,y} * F_{ywe}) = 1.60339$$

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)

$$\phi_{psh,x} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{psh2} * F_{ywe2} = 1.60339$$

$$\phi_{ps1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.0020944$$

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

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

$$h_1 = 400.00$$

$$\phi_{ps2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00026808$$

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

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

$$h_2 = 200.00$$

$$\phi_{psh,y} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{psh2} * F_{ywe2} = 3.13667$$

$$\phi_{ps1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00392699$$

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

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

$$h_1 = 750.00$$

$$\phi_{ps2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00073723$$

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

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

$$h_2 = 550.00$$

$$A_{sec} = 300000.00$$

$$s_1 = 100.00$$

$$s_2 = 250.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 555.55$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 441.5397$$

$$fy_1 = 367.9498$$

$$su_1 = 0.00512$$

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

$l_o/l_{ou,min} = l_b/l_d = 0.30$
 $su_1 = 0.4 \cdot esu_{1,nominal} ((5.5), TBDY) = 0.032$
 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 $fs_1 = (fs_{jacket} \cdot Asl_{ten,jacket} + fs_{core} \cdot Asl_{ten,core}) / Asl_{ten} = 367.9498$
 with $Es_1 = (Es_{jacket} \cdot Asl_{ten,jacket} + Es_{core} \cdot Asl_{ten,core}) / Asl_{ten} = 200000.00$
 $y_2 = 0.00140044$
 $sh_2 = 0.0044814$
 $ft_2 = 441.5397$
 $fy_2 = 367.9498$
 $su_2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.30$
 $su_2 = 0.4 \cdot esu_{2,nominal} ((5.5), TBDY) = 0.032$
 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_2, sh_2, ft_2, fy_2 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = (fs_{jacket} \cdot Asl_{com,jacket} + fs_{core} \cdot Asl_{com,core}) / Asl_{com} = 367.9498$
 with $Es_2 = (Es_{jacket} \cdot Asl_{com,jacket} + Es_{core} \cdot Asl_{com,core}) / Asl_{com} = 200000.00$
 $y_v = 0.00140044$
 $sh_v = 0.0044814$
 $ft_v = 466.8167$
 $fy_v = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.30$
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$
 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 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 $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs_{jacket} \cdot Asl_{mid,jacket} + fs_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 389.0139$
 with $Es_v = (Es_{jacket} \cdot Asl_{mid,jacket} + Es_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 200000.00$
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.04483877$
 $2 = Asl_{com} / (b \cdot d) \cdot (fs_2 / fc) = 0.04483877$
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.01676222$

and confined core properties:

$b = 340.00$
 $d = 677.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.05508907$
 $2 = Asl_{com} / (b \cdot d) \cdot (fs_2 / fc) = 0.05508907$
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.02059413$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$su (4.9) = 0.1553529$
 $Mu = MRc (4.14) = 3.5366E+008$
 $u = su (4.1) = 8.5738376E-006$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 923245.821$

Calculation of Shear Strength at edge 1, $V_{r1} = 923245.821$

$V_{r1} = V_{col} \text{ ((10.3), ASCE 41-17)} = k_n I^* V_{col0}$

$V_{col0} = 923245.821$

$k_n I = 1$ (zero step-static loading)

NOTE: In expression (10-3) ' $V_s = A_v f_y d/s$ ' is replaced by ' $V_s + f^* V_f$ ' where V_f is the contribution of FRPs (11.3), ACI 440).

$= 1$ (normal-weight concrete)

Mean concrete strength: $f_c' = (f_c'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f_c'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 28.23333$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$M/Vd = 2.00$

$\mu_u = 6.8236829\text{E-}012$

$\nu_u = 3.9443045\text{E-}031$

$d = 0.8 \cdot h = 600.00$

$N_u = 11016.808$

$A_g = 300000.00$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} = 602239.733$

where:

$V_{s1} = 523602.964$ is calculated for jacket, with:

$d = 600.00$

$A_v = 157079.633$

$f_y = 555.56$

$s = 100.00$

V_{s1} is multiplied by $\text{Col1} = 1.00$

$s/d = 0.16666667$

$V_{s2} = 78636.768$ is calculated for core, with:

$d = 440.00$

$A_v = 100530.965$

$f_y = 444.44$

$s = 250.00$

V_{s2} is multiplied by $\text{Col2} = 1.00$

$s/d = 0.56818182$

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

From (11-11), ACI 440: $V_s + V_f \leq 847147.582$

$b_w = 400.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 923245.821$

$V_{r2} = V_{col} \text{ ((10.3), ASCE 41-17)} = k_n I^* V_{col0}$

$V_{col0} = 923245.821$

$k_n I = 1$ (zero step-static loading)

NOTE: In expression (10-3) ' $V_s = A_v f_y d/s$ ' is replaced by ' $V_s + f^* V_f$ ' where V_f is the contribution of FRPs (11.3), ACI 440).

$= 1$ (normal-weight concrete)

Mean concrete strength: $f_c' = (f_c'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f_c'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 28.23333$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$M/Vd = 2.00$

$\mu_u = 6.8236829\text{E-}012$

$\nu_u = 3.9443045\text{E-}031$

$d = 0.8 \cdot h = 600.00$

$N_u = 11016.808$

$A_g = 300000.00$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} = 602239.733$

where:

$V_{s1} = 523602.964$ is calculated for jacket, with:

$d = 600.00$

$A_v = 157079.633$

$f_y = 555.56$

$s = 100.00$
 $Vs1$ is multiplied by $Col1 = 1.00$
 $s/d = 0.16666667$
 $Vs2 = 78636.768$ is calculated for core, with:
 $d = 440.00$
 $Av = 100530.965$
 $fy = 444.44$
 $s = 250.00$
 $Vs2$ is multiplied by $Col2 = 1.00$
 $s/d = 0.56818182$
 $Vf ((11-3)-(11.4), ACI 440) = 0.00$
 From $(11-11)$, ACI 440: $Vs + Vf \leq 847147.582$
 $bw = 400.00$

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

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

Constant Properties

 Knowledge Factor, $= 1.00$
 Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
 Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
 Consequently:
 Jacket
 New material of Secondary Member: Concrete Strength, $fc = f_{cm} = 33.00$
 New material of Secondary Member: Steel Strength, $fs = f_{sm} = 555.56$
 Concrete Elasticity, $Ec = 26999.444$
 Steel Elasticity, $Es = 200000.00$
 Existing Column
 Existing material of Secondary Member: Concrete Strength, $fc = f_{cm} = 20.00$
 Existing material of Secondary Member: Steel Strength, $fs = f_{sm} = 444.44$
 Concrete Elasticity, $Ec = 21019.039$
 Steel Elasticity, $Es = 200000.00$
 External Height, $H = 400.00$
 External Width, $W = 750.00$
 Internal Height, $H = 200.00$
 Internal Width, $W = 550.00$
 Cover Thickness, $c = 25.00$
 Element Length, $L = 3000.00$
 Secondary Member
 Ribbed Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Inadequate Lap Length with $lb/l_d = 0.30$
 No FRP Wrapping

Stepwise Properties

 Bending Moment, $M = 1.1088903E-009$
 Shear Force, $V2 = -3386.997$
 Shear Force, $V3 = -3.7626771E-013$
 Axial Force, $F = -16097.112$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $As_t = 0.00$
 -Compression: $As_c = 2676.637$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $Asl_{ten} = 1137.257$
 -Compression: $Asl_{com} = 1137.257$
 -Middle: $Asl_{mid} = 402.1239$
 Longitudinal External Reinforcement Area Distribution (in 3 divisions)
 -Tension: $Asl_{ten,jacket} = 829.3805$
 -Compression: $Asl_{com,jacket} = 829.3805$
 -Middle: $Asl_{mid,jacket} = 402.1239$
 Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $Asl_{ten,core} = 307.8761$
 -Compression: $Asl_{com,core} = 307.8761$
 -Middle: $Asl_{mid,core} = 0.00$
 Mean Diameter of Tension Reinforcement, $DbL = 16.80$

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = u = 0.00198322$
 $u = y + p = 0.00198322$

- Calculation of y -

$y = (My * Ls / 3) / Eleff = 0.00198322 ((4.29), Biskinis Phd))$
 $My = 1.2590E+008$
 $Ls = M/V$ (with $Ls > 0.1 * L$ and $Ls < 2 * L$) = 1500.00
 From table 10.5, ASCE 41_17: $Eleff = factor * Ec * Ig = 3.1741E+013$
 $factor = 0.30$
 $Ag = 300000.00$
 Mean concrete strength: $fc' = (fc'_{jacket} * Area_{jacket} + fc'_{core} * Area_{core}) / Area_{section} = 28.23333$
 $N = 16097.112$
 $Ec * Ig = Ec_{jacket} * Ig_{jacket} + Ec_{core} * Ig_{core} = 1.0580E+014$

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$
 $y_{ten} = 5.3808581E-006$
 with $((10.1), ASCE 41-17)$ $fy = \text{Min}(fy, 1.25 * fy * (lb/d)^{2/3}) = 296.8915$
 $d = 357.00$
 $y = 0.22723402$
 $A = 0.01019927$
 $B = 0.00580293$
 with $pt = 0.00424746$
 $pc = 0.00424746$
 $p_v = 0.00150186$
 $N = 16097.112$
 $b = 750.00$
 $" = 0.12044818$
 $y_{comp} = 2.7496413E-005$
 with $fc = 33.00$
 $Ec = 26999.444$
 $y = 0.22412348$
 $A = 0.00986014$
 $B = 0.00560044$
 with $Es = 200000.00$

Calculation of ratio lb/d

Inadequate Lap Length with $lb/d = 0.30$

- Calculation of p -

From table 10-8: $p = 0.00$

with:

- Columns controlled by inadequate development or splicing along the clear height because $l_b/l_d < 1$

shear control ratio $V_{yE}/V_{ColOE} = 0.19160863$

$d = d_{external} = 357.00$

$s = s_{external} = 0.00$

$t = s_1 + s_2 + 2 \cdot t_f/bw \cdot (f_{fe}/f_s) = 0.00236248$

jacket: $s_1 = A_{v1} \cdot h_1 / (s_1 \cdot A_g) = 0.0020944$

$A_{v1} = 157.0796$, is the total area of all stirrups parallel to loading (shear) direction

$h_1 = 400.00$

$s_1 = 100.00$

core: $s_2 = A_{v2} \cdot h_2 / (s_2 \cdot A_g) = 0.00026808$

$A_{v2} = 100.531$, is the total area of all stirrups parallel to loading (shear) direction

$h_2 = 200.00$

$s_2 = 250.00$

The term $2 \cdot t_f/bw \cdot (f_{fe}/f_s)$ is implemented to account for FRP contribution

where $f = 2 \cdot t_f/bw$ is FRP ratio (EC8 - 3, A.4.4.3(6)) and f_{fe}/f_s normalises f to steel strength

All these variables have already been given in Shear control ratio calculation.

For the normalisation f_s of jacket is used.

$NUD = 16097.112$

$A_g = 300000.00$

$f_{cE} = (f_{c,jacket} \cdot Area_{jacket} + f_{c,core} \cdot Area_{core}) / section_area = 28.23333$

$fy_{lE} = (fy_{ext_Long_Reinf} \cdot Area_{ext_Long_Reinf} + fy_{int_Long_Reinf} \cdot Area_{int_Long_Reinf}) / Area_{Tot_Long_Rein} = 529.9972$

$fy_{tE} = (fy_{ext_Trans_Reinf} \cdot s_1 + fy_{int_Trans_Reinf} \cdot s_2) / (s_1 + s_2) = 542.9506$

$\rho_l = Area_{Tot_Long_Rein} / (b \cdot d) = 0.00999678$

$b = 750.00$

$d = 357.00$

$f_{cE} = 28.23333$

End Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1

At local axis: 2

Integration Section: (a)

Calculation No. 3

column C1, Floor 1

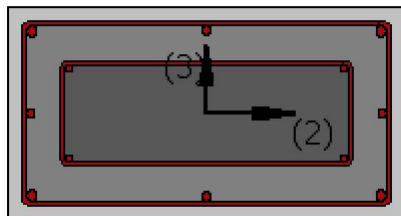
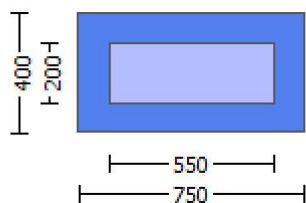
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: Start

Local Axis: (3)



Start Of Calculation of Shear Capacity for element: column JC1 of floor 1

At local axis: 3

Integration Section: (a)

Section Type: rcjrs

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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, $f_c = f_{c_lower_bound} = 25.00$

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

Concrete Elasticity, $E_c = 26999.444$

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, $f_s = f_{s_lower_bound} = 400.00$

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of γ for displacement ductility demand,

the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as

Deformation-Controlled Action (Table C7-1, ASCE 41-17).

Jacket

New material: Concrete Strength, $f_c = f_{cm} = 33.00$

New material: Steel Strength, $f_s = f_{sm} = 555.56$

Existing Column

Existing material: Concrete Strength, $f_c = f_{cm} = 20.00$

Existing material: Steel Strength, $f_s = f_{sm} = 444.44$

#####

External Height, $H = 400.00$

External Width, $W = 750.00$

Internal Height, $H = 200.00$

Internal Width, $W = 550.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_o/l_{ou,min} = l_b/l_d = 0.30$

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 1.1088903E-009$

Shear Force, $V_a = -3.7626771E-013$

EDGE -B-

Bending Moment, Mb = 2.2170426E-011

Shear Force, Vb = 3.7626771E-013

BOTH EDGES

Axial Force, F = -16097.112

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: Aslt = 0.00

-Compression: Aslc = 2676.637

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: Asl,ten = 1137.257

-Compression: Asl,com = 1137.257

-Middle: Asl,mid = 402.1239

Mean Diameter of Tension Reinforcement, DbL,ten = 16.80

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = *Vn = 534028.057

Vn ((10.3), ASCE 41-17) = knl*VCol0 = 534028.057

VCol = 534028.057

knl = 1.00

displacement_ductility_demand = 0.00

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

= 1 (normal-weight concrete)

Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 21.70, but fc'^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)

M/Vd = 2.00

Mu = 1.1088903E-009

Vu = 3.7626771E-013

d = 0.8*h = 320.00

Nu = 16097.112

Ag = 300000.00

From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 251327.412

where:

Vs1 = 251327.412 is calculated for jacket, with:

d = 320.00

Av = 157079.633

fy = 500.00

s = 100.00

Vs1 is multiplied by Col1 = 1.00

s/d = 0.3125

Vs2 = 0.00 is calculated for core, with:

d = 160.00

Av = 100530.965

fy = 400.00

s = 250.00

Vs2 is multiplied by Col2 = 0.00

s/d = 1.5625

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

From (11-11), ACI 440: Vs + Vf <= 742690.493

bw = 750.00

displacement_ductility_demand is calculated as / y

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

From analysis, chord rotation = 1.8329987E-020

y = (My*Ls/3)/Eleff = 0.00198322 ((4.29),Biskinis Phd))

My = 1.2590E+008

Ls = M/V (with Ls > 0.1*L and Ls < 2*L) = 1500.00

From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 3.1741E+013

factor = 0.30
Ag = 300000.00
Mean concrete strength: $fc' = (fc'_{jacket} \cdot Area_{jacket} + fc'_{core} \cdot Area_{core}) / Area_{section} = 28.23333$
N = 16097.112
 $Ec \cdot Ig = Ec_{jacket} \cdot Ig_{jacket} + Ec_{core} \cdot Ig_{core} = 1.0580E+014$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$
 $y_{ten} = 5.3808581E-006$
with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25 \cdot f_y \cdot (I_b/I_d)^{2/3}) = 296.8915$
d = 357.00
 $y = 0.22723402$
A = 0.01019927
B = 0.00580293
with pt = 0.00424746
pc = 0.00424746
pv = 0.00150186
N = 16097.112
b = 750.00
" = 0.12044818
 $y_{comp} = 2.7496413E-005$
with $fc = 33.00$
Ec = 26999.444
 $y = 0.22412348$
A = 0.00986014
B = 0.00560044
with Es = 200000.00

Calculation of ratio I_b/I_d

Inadequate Lap Length with $I_b/I_d = 0.30$

End Of Calculation of Shear Capacity for element: column JC1 of floor 1

At local axis: 3

Integration Section: (a)

Calculation No. 4

column C1, Floor 1

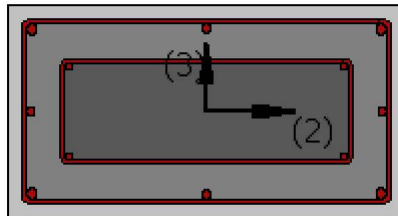
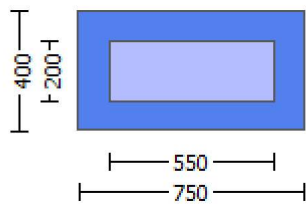
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (ϕ_r)

Edge: Start

Local Axis: (3)



Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjrs

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 33.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.56$

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 20.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 444.44$

Concrete Elasticity, $E_c = 21019.039$

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, $f_s = 1.25 \cdot f_{sm} = 694.45$

Existing Column

Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 555.55$

#####

External Height, $H = 400.00$

External Width, $W = 750.00$

Internal Height, $H = 200.00$

Internal Width, $W = 550.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length, $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_o/l_{ou,min} = 0.30$

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = -1.3927229E-031$

EDGE -B-

Shear Force, $V_b = 1.3927229E-031$

BOTH EDGES

Axial Force, $F = -11016.808$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 0.00$

-Compression: $As_c = 2676.637$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten} = 1137.257$

-Compression: $As_{c,com} = 1137.257$

-Middle: $As_{mid} = 402.1239$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.19160863$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 115015.186$ with

$M_{pr1} = \text{Max}(\mu_{1+}, \mu_{1-}) = 1.7252E+008$

$\mu_{1+} = 1.7252E+008$, 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

$\mu_{1-} = 1.7252E+008$, 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

$M_{pr2} = \text{Max}(\mu_{2+}, \mu_{2-}) = 1.7252E+008$

$\mu_{2+} = 1.7252E+008$, 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

$\mu_{2-} = 1.7252E+008$, 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

Calculation of μ_{1+}

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

$\phi_u = 1.7214953E-005$

$M_u = 1.7252E+008$

with full section properties:

$b = 750.00$

$d = 357.00$

$d' = 43.00$

$v = 0.00124684$

$N = 11016.808$

$f_c = 33.00$

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

Final value of ϕ_u : $\phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.0052143$

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

From (5.4b), TB DY: $\phi_u = 0.0052143$

we (5.4c) $= 0.00183676$

$a_{se} ((5.4d), \text{TB DY}) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.12601038$

$a_{se1} = 0.12601038$

$b_{o_1} = 690.00$

$h_{o_1} = 340.00$

$b_{i2_1} = 1.1834E+006$

$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.12601038$

$b_{o_2} = 542.00$

$h_{o_2} = 192.00$

$b_{i2_2} = 661256.00$

$\phi_{sh,min} * F_{ywe} = \text{Min}(\phi_{sh,x} * F_{ywe}, \phi_{sh,y} * F_{ywe}) = 1.60339$

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)

$\phi_{sh,x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.60339$

$\phi_{sh1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.0020944$

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

No stirrups, $n_{s_1} = 2.00$

$h_1 = 400.00$

$\phi_{sh2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00026808$

Ash2 = Astir_2*ns_2 = 100.531
 No stirups, ns_2 = 2.00
 h2 = 200.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.13667
 ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
 Ash1 = Astir_1*ns_1 = 157.0796
 No stirups, ns_1 = 2.00
 h1 = 750.00
 ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
 Ash2 = Astir_2*ns_2 = 100.531
 No stirups, ns_2 = 2.00
 h2 = 550.00

Asec = 300000.00

s1 = 100.00

s2 = 250.00

fywe1 = 694.45

fywe2 = 555.55

fce = 33.00

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

c = confinement factor = 1.00

y1 = 0.00140044

sh1 = 0.0044814

ft1 = 441.5397

fy1 = 367.9498

su1 = 0.00512

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

lo/lou,min = lb/ld = 0.30

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

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

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

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

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 367.9498

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

y2 = 0.00140044

sh2 = 0.0044814

ft2 = 441.5397

fy2 = 367.9498

su2 = 0.00512

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

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

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

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

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

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

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 367.9498

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

yv = 0.00140044

shv = 0.0044814

ftv = 466.8167

fyv = 389.0139

suv = 0.00512

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

lo/lou,min = lb/ld = 0.30

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

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

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

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

characteristic value $f_{sv} = f_{sv}/1.2$, 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 $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 389.0139$

with $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1}/f_c) = 0.04735912$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2}/f_c) = 0.04735912$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv}/f_c) = 0.01770442$

and confined core properties:

$b = 690.00$

$d = 327.00$

$d' = 13.00$

$f_{cc} \text{ (5A.2, TBDY)} = 33.00$

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

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

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1}/f_c) = 0.05619999$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2}/f_c) = 0.05619999$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv}/f_c) = 0.02100943$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$su \text{ (4.9)} = 0.16690234$

$Mu = MR_c \text{ (4.14)} = 1.7252E+008$

$u = su \text{ (4.1)} = 1.7214953E-005$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Mu_1 -

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

$u = 1.7214953E-005$

$Mu = 1.7252E+008$

with full section properties:

$b = 750.00$

$d = 357.00$

$d' = 43.00$

$v = 0.00124684$

$N = 11016.808$

$f_c = 33.00$

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

Final value of cu : $cu^* = \text{shear_factor} \cdot \text{Max}(cu, cc) = 0.0052143$

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

From (5.4b), TBDY: $cu = 0.0052143$

we (5.4c) $= 0.00183676$

$ase \text{ ((5.4d), TBDY)} = (ase1 \cdot A_{ext} + ase2 \cdot A_{int}) / A_{sec} = 0.12601038$

$ase1 = 0.12601038$

$bo_1 = 690.00$

$ho_1 = 340.00$

$bi2_1 = 1.1834E+006$

$ase2 = \text{Max}(ase1, ase2) = 0.12601038$

$bo_2 = 542.00$

$ho_2 = 192.00$

$bi2_2 = 661256.00$

$psh_{min} \cdot F_{ywe} = \text{Min}(psh_x \cdot F_{ywe}, psh_y \cdot F_{ywe}) = 1.60339$

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)

$psh_x \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 1.60339$

$$ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.0020944$$

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

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

$$h1 = 400.00$$

$$ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00026808$$

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

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

$$h2 = 200.00$$

$$psh_y \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 3.13667$$

$$ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00392699$$

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

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

$$h1 = 750.00$$

$$ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00073723$$

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

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

$$h2 = 550.00$$

$$Asec = 300000.00$$

$$s1 = 100.00$$

$$s2 = 250.00$$

$$fywe1 = 694.45$$

$$fywe2 = 555.55$$

$$fce = 33.00$$

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

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

$$y1 = 0.00140044$$

$$sh1 = 0.0044814$$

$$ft1 = 441.5397$$

$$fy1 = 367.9498$$

$$su1 = 0.00512$$

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

$$lo/lou, \min = lb/ld = 0.30$$

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

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

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

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

$$\text{with } fs1 = (fs_{\text{jacket}} \cdot Asl, \text{ten, jacket} + fs_{\text{core}} \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 367.9498$$

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

$$y2 = 0.00140044$$

$$sh2 = 0.0044814$$

$$ft2 = 441.5397$$

$$fy2 = 367.9498$$

$$su2 = 0.00512$$

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

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

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

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

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

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

$$\text{with } fs2 = (fs_{\text{jacket}} \cdot Asl, \text{com, jacket} + fs_{\text{core}} \cdot Asl, \text{com, core}) / Asl, \text{com} = 367.9498$$

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

$$yv = 0.00140044$$

$$shv = 0.0044814$$

$$ftv = 466.8167$$

$$fyv = 389.0139$$

$$suv = 0.00512$$

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

$l_o/l_{ou,min} = l_b/l_d = 0.30$
 $suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv , shv , ftv , fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1$, $sh1$, $ft1$, $fy1$, are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs_jacket * Asl_mid_jacket + fs_mid * Asl_mid_core) / Asl_mid = 389.0139$
 with $Esv = (Es_jacket * Asl_mid_jacket + Es_mid * Asl_mid_core) / Asl_mid = 200000.00$
 $1 = Asl_ten / (b * d) * (fs1 / fc) = 0.04735912$
 $2 = Asl_com / (b * d) * (fs2 / fc) = 0.04735912$
 $v = Asl_mid / (b * d) * (fsv / fc) = 0.01770442$
 and confined core properties:
 $b = 690.00$
 $d = 327.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl_ten / (b * d) * (fs1 / fc) = 0.05619999$
 $2 = Asl_com / (b * d) * (fs2 / fc) = 0.05619999$
 $v = Asl_mid / (b * d) * (fsv / fc) = 0.02100943$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < vsy2$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.16690234$
 $Mu = MRc (4.14) = 1.7252E+008$
 $u = su (4.1) = 1.7214953E-005$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of $Mu2+$

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

$u = 1.7214953E-005$
 $Mu = 1.7252E+008$

with full section properties:

$b = 750.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.00124684$
 $N = 11016.808$
 $fc = 33.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu^* = $shear_factor * Max(cu, cc) = 0.0052143$
 The $Shear_factor$ is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.0052143$
 $we (5.4c) = 0.00183676$
 $ase ((5.4d), TBDY) = (ase1 * Aext + ase2 * Aint) / Asec = 0.12601038$
 $ase1 = 0.12601038$
 $bo_1 = 690.00$
 $ho_1 = 340.00$
 $bi2_1 = 1.1834E+006$
 $ase2 = Max(ase1, ase2) = 0.12601038$
 $bo_2 = 542.00$
 $ho_2 = 192.00$
 $bi2_2 = 661256.00$

$psh,min*Fywe = \text{Min}(psh,x*Fywe, psh,y*Fywe) = 1.60339$
 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)

$psh_x*Fywe = psh1*Fywe1 + ps2*Fywe2 = 1.60339$
 $ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.0020944$
 $Ash1 = Astir_1*ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00026808$
 $Ash2 = Astir_2*ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

$psh_y*Fywe = psh1*Fywe1 + ps2*Fywe2 = 3.13667$
 $ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00392699$
 $Ash1 = Astir_1*ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 750.00$
 $ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00073723$
 $Ash2 = Astir_2*ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 550.00$

$Asec = 300000.00$
 $s1 = 100.00$
 $s2 = 250.00$
 $fywe1 = 694.45$
 $fywe2 = 555.55$
 $fce = 33.00$

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

$y1 = 0.00140044$
 $sh1 = 0.0044814$
 $ft1 = 441.5397$
 $fy1 = 367.9498$
 $su1 = 0.00512$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/ld = 0.30$

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

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 $fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 367.9498$

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

$y2 = 0.00140044$
 $sh2 = 0.0044814$
 $ft2 = 441.5397$
 $fy2 = 367.9498$
 $su2 = 0.00512$

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

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

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

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 $fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 367.9498$

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

$yv = 0.00140044$
 $shv = 0.0044814$
 $ftv = 466.8167$

```

fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lo,min = lb/ld = 0.30
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fsjacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04735912
2 = Asl,com/(b*d)*(fs2/fc) = 0.04735912
v = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05619999
2 = Asl,com/(b*d)*(fs2/fc) = 0.05619999
v = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.16690234
Mu = MRc (4.14) = 1.7252E+008
u = su (4.1) = 1.7214953E-005

```

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

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

```

u = 1.7214953E-005
Mu = 1.7252E+008

```

with full section properties:

```

b = 750.00
d = 357.00
d' = 43.00
v = 0.00124684
N = 11016.808
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.0052143
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0052143
we (5.4c) = 0.00183676
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00

```

$bi2_1 = 1.1834E+006$
 $ase2 = \text{Max}(ase1, ase2) = 0.12601038$
 $bo_2 = 542.00$
 $ho_2 = 192.00$
 $bi2_2 = 661256.00$
 $psh, \min * Fywe = \text{Min}(psh, x * Fywe, psh, y * Fywe) = 1.60339$
 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)

$psh_x * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 1.60339$
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.0020944$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00026808$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

$psh_y * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 3.13667$
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.00392699$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 750.00$
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00073723$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 550.00$

$Asec = 300000.00$
 $s1 = 100.00$
 $s2 = 250.00$
 $fywe1 = 694.45$
 $fywe2 = 555.55$
 $fce = 33.00$

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

$y1 = 0.00140044$
 $sh1 = 0.0044814$
 $ft1 = 441.5397$
 $fy1 = 367.9498$
 $su1 = 0.00512$

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

$lo/lou, \min = lb/ld = 0.30$

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

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 $fs1 = (fs, \text{jacket} * Asl, \text{ten, jacket} + fs, \text{core} * Asl, \text{ten, core}) / Asl, \text{ten} = 367.9498$

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

$y2 = 0.00140044$
 $sh2 = 0.0044814$
 $ft2 = 441.5397$
 $fy2 = 367.9498$
 $su2 = 0.00512$

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

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

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

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 = 367.9498
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04735912
2 = Asl,com/(b*d)*(fs2/fc) = 0.04735912
v = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05619999
2 = Asl,com/(b*d)*(fs2/fc) = 0.05619999
v = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.16690234
Mu = MRc (4.14) = 1.7252E+008
u = su (4.1) = 1.7214953E-005

```

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength $V_r = \min(V_{r1}, V_{r2}) = 600261.003$

Calculation of Shear Strength at edge 1, $V_{r1} = 600261.003$

$V_{r1} = V_{CoI} ((10.3), ASCE 41-17) = k_{nl} * V_{CoI0}$

$V_{CoI0} = 600261.003$

$k_{nl} = 1$ (zero step-static loading)

NOTE: In expression (10-3) ' $V_s = A_v * f_y * d / s$ ' is replaced by ' $V_{s+} = f * V_f$ ' where V_f is the contribution of FRPs (11.3), ACI 440).

= 1 (normal-weight concrete)

Mean concrete strength: $f'_c = (f'_c \text{ jacket} * \text{Area jacket} + f'_c \text{ core} * \text{Area core}) / \text{Area section} = 28.23333$, but $f'_c^{0.5} \leq 8.3 \text{ MPa}$ (22.5.3.1, ACI 318-14)

$M/Vd = 2.00$

$\mu_u = 1.0002017E-011$

$\mu_v = 1.3927229E-031$

$d = 0.8 * h = 320.00$

$N_u = 11016.808$

$A_g = 300000.00$
 From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} = 279254.914$
 where:
 $V_{s1} = 279254.914$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 555.56$
 $s = 100.00$
 V_{s1} is multiplied by $Col1 = 1.00$
 $s/d = 0.3125$
 $V_{s2} = 0.00$ is calculated for core, with:
 $d = 160.00$
 $A_v = 100530.965$
 $f_y = 444.44$
 $s = 250.00$
 V_{s2} is multiplied by $Col2 = 0.00$
 $s/d = 1.5625$
 $V_f ((11-3)-(11.4), ACI 440) = 0.00$
 From (11-11), ACI 440: $V_s + V_f \leq 847147.582$
 $bw = 750.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 600261.003$
 $V_{r2} = V_{Col} ((10.3), ASCE 41-17) = knl * V_{Col0}$
 $V_{Col0} = 600261.003$
 $knl = 1$ (zero step-static loading)

NOTE: In expression (10-3) ' $V_s = A_v * f_y * d / s$ ' is replaced by ' $V_s + f * V_f$ '
 where V_f is the contribution of FRPs (11.3), ACI 440).

$= 1$ (normal-weight concrete)
 Mean concrete strength: $f_c' = (f_c'_{jacket} * Area_{jacket} + f_c'_{core} * Area_{core}) / Area_{section} = 28.23333$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $M/Vd = 2.00$
 $M_u = 1.0002017E-011$
 $V_u = 1.3927229E-031$
 $d = 0.8 * h = 320.00$
 $N_u = 11016.808$
 $A_g = 300000.00$
 From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} = 279254.914$
 where:
 $V_{s1} = 279254.914$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 555.56$
 $s = 100.00$
 V_{s1} is multiplied by $Col1 = 1.00$
 $s/d = 0.3125$
 $V_{s2} = 0.00$ is calculated for core, with:
 $d = 160.00$
 $A_v = 100530.965$
 $f_y = 444.44$
 $s = 250.00$
 V_{s2} is multiplied by $Col2 = 0.00$
 $s/d = 1.5625$
 $V_f ((11-3)-(11.4), ACI 440) = 0.00$
 From (11-11), ACI 440: $V_s + V_f \leq 847147.582$
 $bw = 750.00$

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

Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1

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

Constant Properties

Knowledge Factor, $\phi = 1.00$
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.56$
Concrete Elasticity, $E_c = 26999.444$
Steel Elasticity, $E_s = 200000.00$
Existing Column
Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 20.00$
Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 444.44$
Concrete Elasticity, $E_c = 21019.039$
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, $f_s = 1.25 \cdot f_{sm} = 694.45$
Existing Column
Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 555.55$

External Height, $H = 400.00$
External Width, $W = 750.00$
Internal Height, $H = 200.00$
Internal Width, $W = 550.00$
Cover Thickness, $c = 25.00$
Mean Confinement Factor overall section = 1.00
Element Length, $L = 3000.00$
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with $l_o/l_{ou,min} = 0.30$
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, $V_a = -3.9443045E-031$
EDGE -B-
Shear Force, $V_b = 3.9443045E-031$
BOTH EDGES
Axial Force, $F = -11016.808$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $As_t = 0.00$
-Compression: $As_c = 2676.637$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $As_{t,ten} = 1137.257$
-Compression: $As_{c,com} = 1137.257$
-Middle: $As_{l,mid} = 402.1239$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.25537128$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 235770.47$
with

$$M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 3.5366\text{E}+008$$

$M_{u1+} = 3.5366\text{E}+008$, 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

$M_{u1-} = 3.5366\text{E}+008$, 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

$$M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 3.5366\text{E}+008$$

$M_{u2+} = 3.5366\text{E}+008$, 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

$M_{u2-} = 3.5366\text{E}+008$, 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

Calculation of M_{u1+}

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

$$\phi_u = 8.5738376\text{E}-006$$

$$M_u = 3.5366\text{E}+008$$

with full section properties:

$$b = 400.00$$

$$d = 707.00$$

$$d' = 43.00$$

$$v = 0.00118049$$

$$N = 11016.808$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.0052143$$

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

$$\text{From (5.4b), TBDY: } \phi_u = 0.0052143$$

$$w_e(5.4c) = 0.00183676$$

$$a_{se}((5.4d), \text{TBDY}) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.12601038$$

$$a_{se1} = 0.12601038$$

$$b_{o_1} = 690.00$$

$$h_{o_1} = 340.00$$

$$b_{i2_1} = 1.1834\text{E}+006$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.12601038$$

$$b_{o_2} = 542.00$$

$$h_{o_2} = 192.00$$

$$b_{i2_2} = 661256.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.60339$$

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)

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.60339$$

$$p_{sh1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.0020944$$

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

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

$$h_1 = 400.00$$

$$p_{sh2}(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00026808$$

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

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

$$h_2 = 200.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 3.13667$$

$$p_{sh1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00392699$$

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

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

$$h_1 = 750.00$$

$$p_{sh2}(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00073723$$

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

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

$$h_2 = 550.00$$

$$A_{sec} = 300000.00$$

$$s_1 = 100.00$$

$s_2 = 250.00$
 $fy_{we1} = 694.45$
 $fy_{we2} = 555.55$
 $f_{ce} = 33.00$
 From ((5A.5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$
 $y_1 = 0.00140044$
 $sh_1 = 0.0044814$
 $ft_1 = 441.5397$
 $fy_1 = 367.9498$
 $su_1 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou, \min = lb/ld = 0.30$
 $su_1 = 0.4 * esu_1 \text{ nominal } ((5.5), \text{TBDY}) = 0.032$
 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 $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_1 = (fs_{jacket} * Asl, \text{ten, jacket} + fs_{core} * Asl, \text{ten, core}) / Asl, \text{ten} = 367.9498$
 with $Es_1 = (Es_{jacket} * Asl, \text{ten, jacket} + Es_{core} * Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$
 $y_2 = 0.00140044$
 $sh_2 = 0.0044814$
 $ft_2 = 441.5397$
 $fy_2 = 367.9498$
 $su_2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou, \min = lb/lb, \min = 0.30$
 $su_2 = 0.4 * esu_2 \text{ nominal } ((5.5), \text{TBDY}) = 0.032$
 From table 5A.1, TBDY: $esu_2 \text{ nominal} = 0.08$,
 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, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = (fs_{jacket} * Asl, \text{com, jacket} + fs_{core} * Asl, \text{com, core}) / Asl, \text{com} = 367.9498$
 with $Es_2 = (Es_{jacket} * Asl, \text{com, jacket} + Es_{core} * Asl, \text{com, core}) / Asl, \text{com} = 200000.00$
 $y_v = 0.00140044$
 $sh_v = 0.0044814$
 $ft_v = 466.8167$
 $fy_v = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou, \min = lb/ld = 0.30$
 $suv = 0.4 * esuv \text{ nominal } ((5.5), \text{TBDY}) = 0.032$
 From table 5A.1, TBDY: $esuv \text{ nominal} = 0.08$,
 considering characteristic value $fsyv = fs_v/1.2$, from table 5.1, TBDY
 For calculation of $esuv \text{ nominal}$ 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 $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_v = (fs_{jacket} * Asl, \text{mid, jacket} + fs_{mid} * Asl, \text{mid, core}) / Asl, \text{mid} = 389.0139$
 with $Es_v = (Es_{jacket} * Asl, \text{mid, jacket} + Es_{mid} * Asl, \text{mid, core}) / Asl, \text{mid} = 200000.00$
 $1 = Asl, \text{ten} / (b * d) * (fs_1 / f_c) = 0.04483877$
 $2 = Asl, \text{com} / (b * d) * (fs_2 / f_c) = 0.04483877$
 $v = Asl, \text{mid} / (b * d) * (fs_v / f_c) = 0.01676222$
 and confined core properties:
 $b = 340.00$
 $d = 677.00$
 $d' = 13.00$
 $f_{cc} (5A.2, \text{TBDY}) = 33.00$
 $cc (5A.5, \text{TBDY}) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl, \text{ten} / (b * d) * (fs_1 / f_c) = 0.05508907$
 $2 = Asl, \text{com} / (b * d) * (fs_2 / f_c) = 0.05508907$

$v = A_{sl, mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.02059413$
Case/Assumption: Unconfined full section - Steel rupture
satisfies Eq. (4.3)

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

--->
 $\mu_u (4.9) = 0.1553529$
 $\mu_u = M_{Rc} (4.14) = 3.5366E+008$
 $u = \mu_u (4.1) = 8.5738376E-006$

Calculation of ratio I_b/I_d

Inadequate Lap Length with $I_b/I_d = 0.30$

Calculation of μ_{u1} -

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

$u = 8.5738376E-006$
 $\mu_u = 3.5366E+008$

with full section properties:

$b = 400.00$
 $d = 707.00$
 $d' = 43.00$
 $v = 0.00118049$
 $N = 11016.808$
 $f_c = 33.00$
 $\alpha (5A.5, TBDY) = 0.002$
Final value of μ_u : $\mu_u^* = \text{shear_factor} \cdot \text{Max}(\mu_u, \mu_c) = 0.0052143$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $\mu_u = 0.0052143$
 $\mu_w (5.4c) = 0.00183676$
 $\alpha_{se} ((5.4d), TBDY) = (\alpha_{se1} \cdot A_{ext} + \alpha_{se2} \cdot A_{int}) / A_{sec} = 0.12601038$
 $\alpha_{se1} = 0.12601038$
 $b_{o_1} = 690.00$
 $h_{o_1} = 340.00$
 $b_{i2_1} = 1.1834E+006$
 $\alpha_{se2} = \text{Max}(\alpha_{se1}, \alpha_{se2}) = 0.12601038$
 $b_{o_2} = 542.00$
 $h_{o_2} = 192.00$
 $b_{i2_2} = 661256.00$
 $\mu_{sh, min} \cdot F_{ywe} = \text{Min}(\mu_{sh, x} \cdot F_{ywe}, \mu_{sh, y} \cdot F_{ywe}) = 1.60339$

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

$\mu_{sh, x} \cdot F_{ywe} = \mu_{sh1} \cdot F_{ywe1} + \mu_{sh2} \cdot F_{ywe2} = 1.60339$
 $\mu_{sh1} \text{ (external)} = (A_{sh1} \cdot h_1 / s_1) / A_{sec} = 0.0020944$
 $A_{sh1} = A_{stir_1} \cdot n_{s_1} = 157.0796$
No stirrups, $n_{s_1} = 2.00$
 $h_1 = 400.00$
 $\mu_{sh2} \text{ (internal)} = (A_{sh2} \cdot h_2 / s_2) / A_{sec} = 0.00026808$
 $A_{sh2} = A_{stir_2} \cdot n_{s_2} = 100.531$
No stirrups, $n_{s_2} = 2.00$
 $h_2 = 200.00$

$\mu_{sh, y} \cdot F_{ywe} = \mu_{sh1} \cdot F_{ywe1} + \mu_{sh2} \cdot F_{ywe2} = 3.13667$
 $\mu_{sh1} \text{ (external)} = (A_{sh1} \cdot h_1 / s_1) / A_{sec} = 0.00392699$
 $A_{sh1} = A_{stir_1} \cdot n_{s_1} = 157.0796$
No stirrups, $n_{s_1} = 2.00$
 $h_1 = 750.00$
 $\mu_{sh2} \text{ (internal)} = (A_{sh2} \cdot h_2 / s_2) / A_{sec} = 0.00073723$
 $A_{sh2} = A_{stir_2} \cdot n_{s_2} = 100.531$

No stirrups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00

s1 = 100.00

s2 = 250.00

fywe1 = 694.45

fywe2 = 555.55

fce = 33.00

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

c = confinement factor = 1.00

y1 = 0.00140044

sh1 = 0.0044814

ft1 = 441.5397

fy1 = 367.9498

su1 = 0.00512

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

lo/lou,min = lb/ld = 0.30

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

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

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

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

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 367.9498

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

y2 = 0.00140044

sh2 = 0.0044814

ft2 = 441.5397

fy2 = 367.9498

su2 = 0.00512

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

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

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

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

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

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

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 367.9498

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

yv = 0.00140044

shv = 0.0044814

ftv = 466.8167

fyv = 389.0139

suv = 0.00512

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

lo/lou,min = lb/ld = 0.30

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

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

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

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

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

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

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

1 = Asl,ten/(b*d)*(fs1/fc) = 0.04483877

2 = Asl,com/(b*d)*(fs2/fc) = 0.04483877

v = Asl,mid/(b*d)*(fsv/fc) = 0.01676222

and confined core properties:

b = 340.00

d = 677.00

d' = 13.00

```

fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05508907
2 = Asl,com/(b*d)*(fs2/fc) = 0.05508907
v = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.1553529
Mu = MRc (4.14) = 3.5366E+008
u = su (4.1) = 8.5738376E-006

```

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

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

u = 8.5738376E-006

Mu = 3.5366E+008

with full section properties:

```

b = 400.00
d = 707.00
d' = 43.00
v = 0.00118049
N = 11016.808
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.0052143
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0052143
we (5.4c) = 0.00183676
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
bi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
bi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.60339
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 = 1.60339
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

```

```

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.13667
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699

```


$Ash1 = Astir_1 * ns_1 = 157.0796$
 $No\ stirups, ns_1 = 2.00$
 $h1 = 750.00$
 $ps2\ (internal) = (Ash2 * h2 / s2) / Asec = 0.00073723$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 $No\ stirups, ns_2 = 2.00$
 $h2 = 550.00$

$Asec = 300000.00$

$s1 = 100.00$

$s2 = 250.00$

$fywe1 = 694.45$

$fywe2 = 555.55$

$fce = 33.00$

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

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

$y1 = 0.00140044$

$sh1 = 0.0044814$

$ft1 = 441.5397$

$fy1 = 367.9498$

$su1 = 0.00512$

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

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

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

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

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

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

with $fs1 = (fs,jacket * Asl,ten,jacket + fs,core * Asl,ten,core) / Asl,ten = 367.9498$

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

$y2 = 0.00140044$

$sh2 = 0.0044814$

$ft2 = 441.5397$

$fy2 = 367.9498$

$su2 = 0.00512$

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

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

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

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

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

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

with $fs2 = (fs,jacket * Asl,com,jacket + fs,core * Asl,com,core) / Asl,com = 367.9498$

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

$yv = 0.00140044$

$shv = 0.0044814$

$ftv = 466.8167$

$fyv = 389.0139$

$suv = 0.00512$

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

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

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

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

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

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

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

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

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

$1 = Asl,ten / (b * d) * (fs1 / fc) = 0.04483877$

$2 = Asl,com / (b * d) * (fs2 / fc) = 0.04483877$

```

v = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05508907
2 = Asl,com/(b*d)*(fs2/fc) = 0.05508907
v = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.1553529
Mu = MRc (4.14) = 3.5366E+008
u = su (4.1) = 8.5738376E-006

```

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 8.5738376E-006
Mu = 3.5366E+008

with full section properties:

```

b = 400.00
d = 707.00
d' = 43.00
v = 0.00118049
N = 11016.808
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.0052143
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0052143
we (5.4c) = 0.00183676
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
bi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
bi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.60339
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 = 1.60339
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531

```

No stirups, ns_2 = 2.00
h2 = 200.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.13667
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00

s1 = 100.00

s2 = 250.00

fywe1 = 694.45

fywe2 = 555.55

fce = 33.00

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

c = confinement factor = 1.00

y1 = 0.00140044

sh1 = 0.0044814

ft1 = 441.5397

fy1 = 367.9498

su1 = 0.00512

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

lo/lou,min = lb/ld = 0.30

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

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

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

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

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 367.9498

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

y2 = 0.00140044

sh2 = 0.0044814

ft2 = 441.5397

fy2 = 367.9498

su2 = 0.00512

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

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

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

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

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

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

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 367.9498

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

yv = 0.00140044

shv = 0.0044814

ftv = 466.8167

fyv = 389.0139

suv = 0.00512

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

lo/lou,min = lb/ld = 0.30

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

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

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

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs_{jacket} \cdot Asl_{mid,jacket} + fs_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 389.0139$
 with $Es_v = (Es_{jacket} \cdot Asl_{mid,jacket} + Es_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 200000.00$
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.04483877$
 $2 = Asl_{com} / (b \cdot d) \cdot (fs2 / fc) = 0.04483877$
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.01676222$

and confined core properties:

$b = 340.00$
 $d = 677.00$
 $d' = 13.00$
 fcc (5A.2, TBDY) = 33.00
 cc (5A.5, TBDY) = 0.002
 c = confinement factor = 1.00
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.05508907$
 $2 = Asl_{com} / (b \cdot d) \cdot (fs2 / fc) = 0.05508907$
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.02059413$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

su (4.9) = 0.1553529
 $\mu_u = MR_c$ (4.14) = 3.5366E+008
 $u = su$ (4.1) = 8.5738376E-006

Calculation of ratio lb/ld

Inadequate Lap Length with $lb/ld = 0.30$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 923245.821$

Calculation of Shear Strength at edge 1, $V_{r1} = 923245.821$

$V_{r1} = V_{Col}$ ((10.3), ASCE 41-17) = $k_{nl} \cdot V_{Col0}$

$V_{Col0} = 923245.821$

$k_{nl} = 1$ (zero step-static loading)

NOTE: In expression (10-3) ' $V_s = A_v \cdot f_y \cdot d / s$ ' is replaced by ' $V_s + f \cdot V_f$ ' where V_f is the contribution of FRPs (11.3), ACI 440).

$= 1$ (normal-weight concrete)
 Mean concrete strength: $fc' = (fc'_{jacket} \cdot Area_{jacket} + fc'_{core} \cdot Area_{core}) / Area_{section} = 28.23333$, but $fc'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$M/Vd = 2.00$

$\mu_u = 6.8236829E-012$

$V_u = 3.9443045E-031$

$d = 0.8 \cdot h = 600.00$

$N_u = 11016.808$

$A_g = 300000.00$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} = 602239.733$

where:

$V_{s1} = 523602.964$ is calculated for jacket, with:

$d = 600.00$

$A_v = 157079.633$

$f_y = 555.56$

$s = 100.00$

V_{s1} is multiplied by $Col1 = 1.00$

$s/d = 0.16666667$

$V_{s2} = 78636.768$ is calculated for core, with:

$d = 440.00$

$A_v = 100530.965$

$f_y = 444.44$

$s = 250.00$

V_{s2} is multiplied by $Col2 = 1.00$

s/d = 0.56818182
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 847147.582
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 923245.821
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 923245.821
knl = 1 (zero step-static loading)

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

= 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 28.23333, but fc'^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 6.8236829E-012
Vu = 3.9443045E-031
d = 0.8*h = 600.00
Nu = 11016.808
Ag = 300000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 602239.733
where:
Vs1 = 523602.964 is calculated for jacket, with:
d = 600.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by Col1 = 1.00
s/d = 0.16666667
Vs2 = 78636.768 is calculated for core, with:
d = 440.00
Av = 100530.965
fy = 444.44
s = 250.00
Vs2 is multiplied by Col2 = 1.00
s/d = 0.56818182
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 847147.582
bw = 400.00

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

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

Constant Properties

Knowledge Factor, = 1.00
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 20.00$
 Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 444.44$
 Concrete Elasticity, $E_c = 21019.039$
 Steel Elasticity, $E_s = 200000.00$
 External Height, $H = 400.00$
 External Width, $W = 750.00$
 Internal Height, $H = 200.00$
 Internal Width, $W = 550.00$
 Cover Thickness, $c = 25.00$
 Element Length, $L = 3000.00$
 Secondary Member
 Ribbed Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Inadequate Lap Length with $l_b/l_d = 0.30$
 No FRP Wrapping

Stepwise Properties

Bending Moment, $M = -1.1684E+007$
 Shear Force, $V_2 = -3386.997$
 Shear Force, $V_3 = -3.7626771E-013$
 Axial Force, $F = -16097.112$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $As_t = 0.00$
 -Compression: $As_c = 2676.637$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten} = 1137.257$
 -Compression: $As_{c,com} = 1137.257$
 -Middle: $As_{mid} = 402.1239$
 Longitudinal External Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten,jacket} = 829.3805$
 -Compression: $As_{c,com,jacket} = 829.3805$
 -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: $As_{mid,core} = 0.00$
 Mean Diameter of Tension Reinforcement, $Db_L = 16.80$

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $\phi_{u,R} = \phi_u = 0.00264708$
 $\phi_u = \phi_y + \phi_p = 0.00264708$

- Calculation of ϕ_y -

$\phi_y = (M_y * L_s / 3) / E_{eff} = 0.00264708$ ((4.29), Biskinis Phd))
 $M_y = 2.5076E+008$
 $L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 3449.669
 From table 10.5, ASCE 41_17: $E_{eff} = factor * E_c * I_g = 1.0893E+014$
 $factor = 0.30$
 $A_g = 300000.00$
 Mean concrete strength: $f'_c = (f'_c_{jacket} * Area_{jacket} + f'_c_{core} * Area_{core}) / Area_{section} = 28.23333$
 $N = 16097.112$
 $E_c * I_g = E_{c,jacket} * I_{g,jacket} + E_{c,core} * I_{g,core} = 3.6310E+014$

Calculation of Yielding Moment M_y

Calculation of ϕ_y and M_y according to Annex 7 -

```

y = Min( y_ten, y_com)
y_ten = 2.6761016E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^ 2/3) = 296.8915
d = 707.00
y = 0.21540464
A = 0.00965649
B = 0.00521193
with pt = 0.00402142
pc = 0.00402142
pv = 0.00142194
N = 16097.112
b = 400.00
" = 0.06082037
y_comp = 1.4664753E-005
with fc = 33.00
Ec = 26999.444
y = 0.21219612
A = 0.00933541
B = 0.00502021
with Es = 200000.00

```

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

- Calculation of p -

From table 10-8: p = 0.00

with:

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

shear control ratio $V_yE/V_{ColOE} = 0.25537128$

d = d_external = 707.00

s = s_external = 0.00

t = s1 + s2 + 2*tf/bw*(ffe/fs) = 0.00466422

jacket: s1 = $A_{v1} \cdot h1 / (s1 \cdot A_g) = 0.00392699$

Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction

h1 = 750.00

s1 = 100.00

core: s2 = $A_{v2} \cdot h2 / (s2 \cdot A_g) = 0.00073723$

Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction

h2 = 550.00

s2 = 250.00

The term $2 \cdot tf / bw \cdot (ffe/fs)$ is implemented to account for FRP contribution

where $f = 2 \cdot tf / bw$ is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises f to steel strength

All these variables have already been given in Shear control ratio calculation.

For the normalisation fs of jacket is used.

NUD = 16097.112

Ag = 300000.00

f_{cE} = $(f_{c_jacket} \cdot Area_jacket + f_{c_core} \cdot Area_core) / section_area = 28.23333$

f_{yE} = $(f_{y_ext_Long_Reinf} \cdot Area_ext_Long_Reinf + f_{y_int_Long_Reinf} \cdot Area_int_Long_Reinf) / Area_Tot_Long_Rein = 529.9972$

f_{yE} = $(f_{y_ext_Trans_Reinf} \cdot s1 + f_{y_int_Trans_Reinf} \cdot s2) / (s1 + s2) = 537.9964$

pl = $Area_Tot_Long_Rein / (b \cdot d) = 0.00946477$

b = 400.00

d = 707.00

f_{cE} = 28.23333

End Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1

At local axis: 3

Integration Section: (a)

Calculation No. 5

column C1, Floor 1

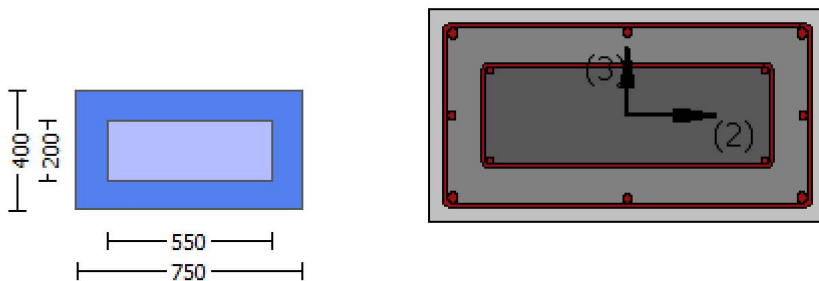
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: End

Local Axis: (2)



Start Of Calculation of Shear Capacity for element: column JC1 of floor 1

At local axis: 2

Integration Section: (b)

Section Type: rcjrs

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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, $f_c = f_{c_lower_bound} = 25.00$

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

Concrete Elasticity, $E_c = 26999.444$

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, $f_s = f_{s_lower_bound} = 400.00$

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of γ for displacement ductility demand, the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as Deformation-Controlled Action (Table C7-1, ASCE 41-17).

Jacket

New material: Concrete Strength, $f_c = f_{cm} = 33.00$

New material: Steel Strength, $f_s = f_{sm} = 555.56$

Existing Column

Existing material: Concrete Strength, $f_c = f_{cm} = 20.00$
 Existing material: Steel Strength, $f_s = f_{sm} = 444.44$
 #####
 External Height, $H = 400.00$
 External Width, $W = 750.00$
 Internal Height, $H = 200.00$
 Internal Width, $W = 550.00$
 Cover Thickness, $c = 25.00$
 Element Length, $L = 3000.00$
 Secondary Member
 Ribbed Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Inadequate Lap Length with $l_o/l_{ou,min} = l_b/l_d = 0.30$
 No FRP Wrapping

Stepwise Properties

EDGE -A-
 Bending Moment, $M_a = -1.1684E+007$
 Shear Force, $V_a = -3386.997$
 EDGE -B-
 Bending Moment, $M_b = 1.5146E+006$
 Shear Force, $V_b = 3386.997$
 BOTH EDGES
 Axial Force, $F = -16097.112$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $A_{st} = 0.00$
 -Compression: $A_{sc} = 2676.637$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $A_{st,ten} = 1137.257$
 -Compression: $A_{st,com} = 1137.257$
 -Middle: $A_{st,mid} = 402.1239$
 Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 16.80$

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = V_n = 824713.342$
 $V_n ((10.3), ASCE 41-17) = knl * V_{ColO} = 824713.342$
 $V_{Col} = 824713.342$
 $knl = 1.00$
 $displacement_ductility_demand = 0.05850534$

NOTE: In expression (10-3) ' $V_s = A_v * f_y * d / s$ ' is replaced by ' $V_s + f * V_f$ '
 where V_f is the contribution of FRPs (11.3), ACI 440).

$= 1$ (normal-weight concrete)
 Mean concrete strength: $f'_c = (f'_c_jacket * Area_jacket + f'_c_core * Area_core) / Area_section = 21.70$, but $f'_c^{0.5} \leq 8.3$
 MPa (22.5.3.1, ACI 318-14)
 $M/Vd = 2.00$
 $M_u = 1.5146E+006$
 $V_u = 3386.997$
 $d = 0.8 * h = 600.00$
 $N_u = 16097.112$
 $A_g = 300000.00$
 From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} = 542012.697$
 where:
 $V_{s1} = 471238.898$ is calculated for jacket, with:
 $d = 600.00$
 $A_v = 157079.633$
 $f_y = 500.00$
 $s = 100.00$
 V_{s1} is multiplied by $Col1 = 1.00$
 $s/d = 0.16666667$

Vs2 = 70773.799 is calculated for core, with:

$$d = 440.00$$

$$A_v = 100530.965$$

$$f_y = 400.00$$

$$s = 250.00$$

Vs2 is multiplied by Col2 = 1.00

$$s/d = 0.56818182$$

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

From (11-11), ACI 440: Vs + Vf <= 742690.493

$$bw = 400.00$$

displacement_ductility_demand is calculated as ϕ / y

- Calculation of ϕ / y for END B -

for rotation axis 3 and integ. section (b)

From analysis, chord rotation $\theta = 2.0075307E-005$

$$y = (M_y * L_s / 3) / E_{eff} = 0.00034314 \text{ ((4.29), Biskinis Phd)}$$

$$M_y = 2.5076E+008$$

$$L_s = M/V \text{ (with } L_s > 0.1 * L \text{ and } L_s < 2 * L) = 447.1746$$

$$\text{From table 10.5, ASCE 41_17: } E_{eff} = \text{factor} * E_c * I_g = 1.0893E+014$$

$$\text{factor} = 0.30$$

$$A_g = 300000.00$$

$$\text{Mean concrete strength: } f_c' = (f_c'_{\text{jacket}} * A_{\text{jacket}} + f_c'_{\text{core}} * A_{\text{core}}) / A_{\text{section}} = 28.23333$$

$$N = 16097.112$$

$$E_c * I_g = E_{c_{\text{jacket}}} * I_{g_{\text{jacket}}} + E_{c_{\text{core}}} * I_{g_{\text{core}}} = 3.6310E+014$$

Calculation of Yielding Moment M_y

Calculation of ϕ and M_y according to Annex 7 -

$$y = \text{Min}(y_{\text{ten}}, y_{\text{com}})$$

$$y_{\text{ten}} = 2.6761016E-006$$

$$\text{with ((10.1), ASCE 41-17) } f_y = \text{Min}(f_y, 1.25 * f_y * (I_b / I_d)^{2/3}) = 296.8915$$

$$d = 707.00$$

$$y = 0.21540464$$

$$A = 0.00965649$$

$$B = 0.00521193$$

$$\text{with } p_t = 0.00402142$$

$$p_c = 0.00402142$$

$$p_v = 0.00142194$$

$$N = 16097.112$$

$$b = 400.00$$

$$\rho = 0.06082037$$

$$y_{\text{comp}} = 1.4664753E-005$$

with $f_c = 33.00$

$$E_c = 26999.444$$

$$y = 0.21219612$$

$$A = 0.00933541$$

$$B = 0.00502021$$

$$\text{with } E_s = 200000.00$$

Calculation of ratio I_b / I_d

Inadequate Lap Length with $I_b / I_d = 0.30$

End Of Calculation of Shear Capacity for element: column JC1 of floor 1

At local axis: 2

Integration Section: (b)

Calculation No. 6

column C1, Floor 1

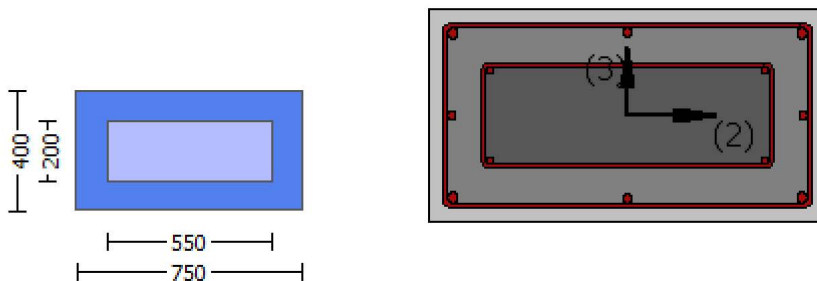
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (ϕ)

Edge: End

Local Axis: (2)



Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjrs

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 33.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.56$

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 20.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 444.44$

Concrete Elasticity, $E_c = 21019.039$

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, $f_s = 1.25 \cdot f_{sm} = 694.45$

Existing Column

Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 555.55$

#####

External Height, $H = 400.00$

External Width, $W = 750.00$
 Internal Height, $H = 200.00$
 Internal Width, $W = 550.00$
 Cover Thickness, $c = 25.00$
 Mean Confinement Factor overall section = 1.00
 Element Length, $L = 3000.00$
 Secondary Member
 Ribbed Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Inadequate Lap Length with $l_o/l_{o,min} = 0.30$
 No FRP Wrapping

Stepwise Properties

At local axis: 3
 EDGE -A-
 Shear Force, $V_a = -1.3927229E-031$
 EDGE -B-
 Shear Force, $V_b = 1.3927229E-031$
 BOTH EDGES
 Axial Force, $F = -11016.808$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $As_t = 0.00$
 -Compression: $As_c = 2676.637$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten} = 1137.257$
 -Compression: $As_{c,com} = 1137.257$
 -Middle: $As_{c,mid} = 402.1239$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.19160863$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 115015.186$
 with
 $M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 1.7252E+008$
 $\mu_{u1+} = 1.7252E+008$, 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
 $\mu_{u1-} = 1.7252E+008$, 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
 $M_{pr2} = \max(\mu_{u2+}, \mu_{u2-}) = 1.7252E+008$
 $\mu_{u2+} = 1.7252E+008$, 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
 $\mu_{u2-} = 1.7252E+008$, 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

Calculation of μ_{u1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 1.7214953E-005$
 $\mu_u = 1.7252E+008$

with full section properties:

$b = 750.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.00124684$
 $N = 11016.808$
 $f_c = 33.00$
 ϕ_o (5A.5, TBDY) = 0.002

Final value of cu : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0052143$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $cu = 0.0052143$
we (5.4c) = 0.00183676
ase ((5.4d), TBDY) = $(ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.12601038$
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
bi2_1 = 1.1834E+006
ase2 = $\text{Max}(ase1, ase2) = 0.12601038$
bo_2 = 542.00
ho_2 = 192.00
bi2_2 = 661256.00
psh,min*Fywe = $\text{Min}(psh, x * F_{ywe}, psh, y * F_{ywe}) = 1.60339$
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 = $psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.60339$
ps1 (external) = $(Ash1 * h1 / s1) / A_{sec} = 0.0020944$
Ash1 = Astir_1*ns_1 = 157.0796
No stirrups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = $(Ash2 * h2 / s2) / A_{sec} = 0.00026808$
Ash2 = Astir_2*ns_2 = 100.531
No stirrups, ns_2 = 2.00
h2 = 200.00

psh_y*Fywe = $psh1 * F_{ywe1} + ps2 * F_{ywe2} = 3.13667$
ps1 (external) = $(Ash1 * h1 / s1) / A_{sec} = 0.00392699$
Ash1 = Astir_1*ns_1 = 157.0796
No stirrups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = $(Ash2 * h2 / s2) / A_{sec} = 0.00073723$
Ash2 = Astir_2*ns_2 = 100.531
No stirrups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00

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

y1 = 0.00140044
sh1 = 0.0044814
ft1 = 441.5397
fy1 = 367.9498
su1 = 0.00512

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

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

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

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

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

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

with $fs1 = (fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 367.9498$

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

y2 = 0.00140044
sh2 = 0.0044814
ft2 = 441.5397
fy2 = 367.9498
su2 = 0.00512

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

and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.30$
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$
 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 $fs_2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 367.9498$
 with $Es_2 = (Es_{jacket} * A_{sl,com,jacket} + Es_{core} * A_{sl,com,core}) / A_{sl,com} = 200000.00$
 $y_v = 0.00140044$
 $sh_v = 0.0044814$
 $ft_v = 466.8167$
 $fy_v = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.30$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsv = fs_v/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fsv = fs_v/1.2$, 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 $fs_v = (fs_{jacket} * A_{sl,mid,jacket} + fs_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 389.0139$
 with $Es_v = (Es_{jacket} * A_{sl,mid,jacket} + Es_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$
 $1 = A_{sl,ten} / (b * d) * (fs_1 / f_c) = 0.04735912$
 $2 = A_{sl,com} / (b * d) * (fs_2 / f_c) = 0.04735912$
 $v = A_{sl,mid} / (b * d) * (fs_v / f_c) = 0.01770442$
 and confined core properties:
 $b = 690.00$
 $d = 327.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten} / (b * d) * (fs_1 / f_c) = 0.05619999$
 $2 = A_{sl,com} / (b * d) * (fs_2 / f_c) = 0.05619999$
 $v = A_{sl,mid} / (b * d) * (fs_v / f_c) = 0.02100943$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y_2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.16690234$
 $Mu = MR_c (4.14) = 1.7252E+008$
 $u = su (4.1) = 1.7214953E-005$

 Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Mu_1 -

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

$$u = 1.7214953E-005$$

$$Mu = 1.7252E+008$$

 with full section properties:

$$b = 750.00$$

$$d = 357.00$$

$d' = 43.00$
 $v = 0.00124684$
 $N = 11016.808$
 $fc = 33.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = shear_factor * Max(cu, cc) = 0.0052143$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.0052143$
 $we (5.4c) = 0.00183676$
 $ase ((5.4d), TBDY) = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.12601038$
 $ase1 = 0.12601038$
 $bo_1 = 690.00$
 $ho_1 = 340.00$
 $bi2_1 = 1.1834E+006$
 $ase2 = Max(ase1, ase2) = 0.12601038$
 $bo_2 = 542.00$
 $ho_2 = 192.00$
 $bi2_2 = 661256.00$
 $psh, min * F_{ywe} = Min(psh, x * F_{ywe}, psh, y * F_{ywe}) = 1.60339$
 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)

$psh, x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.60339$
 $ps1 (external) = (Ash1 * h1 / s1) / A_{sec} = 0.0020944$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 (internal) = (Ash2 * h2 / s2) / A_{sec} = 0.00026808$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

$psh, y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 3.13667$
 $ps1 (external) = (Ash1 * h1 / s1) / A_{sec} = 0.00392699$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 750.00$
 $ps2 (internal) = (Ash2 * h2 / s2) / A_{sec} = 0.00073723$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 550.00$

$A_{sec} = 300000.00$
 $s1 = 100.00$
 $s2 = 250.00$
 $fywe1 = 694.45$
 $fywe2 = 555.55$
 $f_{ce} = 33.00$

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

$y1 = 0.00140044$
 $sh1 = 0.0044814$
 $ft1 = 441.5397$
 $fy1 = 367.9498$
 $su1 = 0.00512$

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

$lo/lo_{u,min} = lb/ld = 0.30$

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

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

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

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

with $fs1 = (fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 367.9498$

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

$y2 = 0.00140044$

```

sh2 = 0.0044814
ft2 = 441.5397
fy2 = 367.9498
su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/lb,min = 0.30
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 367.9498
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/lb = 0.30
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04735912
2 = Asl,com/(b*d)*(fs2/fc) = 0.04735912
v = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05619999
2 = Asl,com/(b*d)*(fs2/fc) = 0.05619999
v = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.16690234
Mu = MRc (4.14) = 1.7252E+008
u = su (4.1) = 1.7214953E-005

```

Calculation of ratio lb/lb

Inadequate Lap Length with lb/lb = 0.30

Calculation of Mu2+

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

u = 1.7214953E-005

$$\mu = 1.7252E+008$$

with full section properties:

$$b = 750.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00124684$$

$$N = 11016.808$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi: \phi^* = \text{shear_factor} * \text{Max}(\phi_c, \phi_s) = 0.0052143$$

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

$$\text{From (5.4b), TB DY: } \phi_c = 0.0052143$$

$$\phi_s (5.4c) = 0.00183676$$

$$A_{se} ((5.4d), \text{TB DY}) = (A_{se1} * A_{ext} + A_{se2} * A_{int}) / A_{sec} = 0.12601038$$

$$A_{se1} = 0.12601038$$

$$b_{o1} = 690.00$$

$$h_{o1} = 340.00$$

$$b_{i21} = 1.1834E+006$$

$$A_{se2} = \text{Max}(A_{se1}, A_{se2}) = 0.12601038$$

$$b_{o2} = 542.00$$

$$h_{o2} = 192.00$$

$$b_{i22} = 661256.00$$

$$\phi_{sh, \min} * F_{ywe} = \text{Min}(\phi_{sh, x} * F_{ywe}, \phi_{sh, y} * F_{ywe}) = 1.60339$$

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)

$$\phi_{sh, x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.60339$$

$$\phi_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.0020944$$

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

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

$$h_1 = 400.00$$

$$\phi_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00026808$$

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

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

$$h_2 = 200.00$$

$$\phi_{sh, y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 3.13667$$

$$\phi_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00392699$$

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

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

$$h_1 = 750.00$$

$$\phi_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00073723$$

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

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

$$h_2 = 550.00$$

$$A_{sec} = 300000.00$$

$$s_1 = 100.00$$

$$s_2 = 250.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 555.55$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 441.5397$$

$$fy_1 = 367.9498$$

$$su_1 = 0.00512$$

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

and also multiplied by the shear_factor according to 15.7.1.4, with

$$\text{Shear_factor} = 1.00$$

$$l_o / l_u, \min = l_b / l_d = 0.30$$

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

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

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.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
with $f_{s1} = (f_{sjacket} \cdot A_{s,ten,jacket} + f_{s,core} \cdot A_{s,ten,core})/A_{s,ten} = 367.9498$
with $E_{s1} = (E_{sjacket} \cdot A_{s,ten,jacket} + E_{s,core} \cdot A_{s,ten,core})/A_{s,ten} = 200000.00$
 $y2 = 0.00140044$
 $sh2 = 0.0044814$
 $ft2 = 441.5397$
 $fy2 = 367.9498$
 $su2 = 0.00512$
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.30$
 $su2 = 0.4 \cdot esu2_{nominal} ((5.5), \text{TBDY}) = 0.032$
From table 5A.1, TBDY: $esu2_{nominal} = 0.08$,
For calculation of $esu2_{nominal}$ and $y2, sh2, ft2, fy2$, it is considered
characteristic value $f_{sy2} = f_{s2}/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
with $f_{s2} = (f_{sjacket} \cdot A_{s,com,jacket} + f_{s,core} \cdot A_{s,com,core})/A_{s,com} = 367.9498$
with $E_{s2} = (E_{sjacket} \cdot A_{s,com,jacket} + E_{s,core} \cdot A_{s,com,core})/A_{s,com} = 200000.00$
 $yv = 0.00140044$
 $shv = 0.0044814$
 $ftv = 466.8167$
 $fyv = 389.0139$
 $suv = 0.00512$
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.30$
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), \text{TBDY}) = 0.032$
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 yv, shv, ftv, fyv , it is considered
characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
with $f_{sv} = (f_{sjacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core})/A_{s,mid} = 389.0139$
with $E_{sv} = (E_{sjacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core})/A_{s,mid} = 200000.00$
 $1 = A_{s,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.04735912$
 $2 = A_{s,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.04735912$
 $v = A_{s,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.01770442$
and confined core properties:
 $b = 690.00$
 $d = 327.00$
 $d' = 13.00$
 $f_{cc} (5A.2, \text{TBDY}) = 33.00$
 $cc (5A.5, \text{TBDY}) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{s,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.05619999$
 $2 = A_{s,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.05619999$
 $v = A_{s,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.02100943$
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
--->
 $su (4.9) = 0.16690234$
 $Mu = MR_c (4.14) = 1.7252E+008$
 $u = su (4.1) = 1.7214953E-005$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of $Mu2$ -

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

$$\phi_u = 1.7214953E-005$$

$$\mu = 1.7252E+008$$

with full section properties:

$$b = 750.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00124684$$

$$N = 11016.808$$

$$f_c = 33.00$$

$$\phi_{0.5A.5, \text{TB DY}} = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.0052143$$

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

$$\text{From (5.4b), TB DY: } \phi_u = 0.0052143$$

$$\phi_{we} \text{ (5.4c)} = 0.00183676$$

$$\phi_{ase} \text{ ((5.4d), TB DY)} = (\phi_{ase1} * A_{ext} + \phi_{ase2} * A_{int}) / A_{sec} = 0.12601038$$

$$\phi_{ase1} = 0.12601038$$

$$b_{o_1} = 690.00$$

$$h_{o_1} = 340.00$$

$$\phi_{bi2_1} = 1.1834E+006$$

$$\phi_{ase2} = \text{Max}(\phi_{ase1}, \phi_{ase2}) = 0.12601038$$

$$b_{o_2} = 542.00$$

$$h_{o_2} = 192.00$$

$$\phi_{bi2_2} = 661256.00$$

$$\phi_{psh, \min} * F_{ywe} = \text{Min}(\phi_{psh, x} * F_{ywe}, \phi_{psh, y} * F_{ywe}) = 1.60339$$

Expression ((5.4d), TB DY) 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)

$$\phi_{psh, x} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{ps2} * F_{ywe2} = 1.60339$$

$$\phi_{ps1} \text{ (external)} = (\phi_{Ash1} * h_1 / s_1) / A_{sec} = 0.0020944$$

$$\phi_{Ash1} = \phi_{Astir_1} * n_{s_1} = 157.0796$$

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

$$h_1 = 400.00$$

$$\phi_{ps2} \text{ (internal)} = (\phi_{Ash2} * h_2 / s_2) / A_{sec} = 0.00026808$$

$$\phi_{Ash2} = \phi_{Astir_2} * n_{s_2} = 100.531$$

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

$$h_2 = 200.00$$

$$\phi_{psh, y} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{ps2} * F_{ywe2} = 3.13667$$

$$\phi_{ps1} \text{ (external)} = (\phi_{Ash1} * h_1 / s_1) / A_{sec} = 0.00392699$$

$$\phi_{Ash1} = \phi_{Astir_1} * n_{s_1} = 157.0796$$

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

$$h_1 = 750.00$$

$$\phi_{ps2} \text{ (internal)} = (\phi_{Ash2} * h_2 / s_2) / A_{sec} = 0.00073723$$

$$\phi_{Ash2} = \phi_{Astir_2} * n_{s_2} = 100.531$$

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

$$h_2 = 550.00$$

$$A_{sec} = 300000.00$$

$$s_1 = 100.00$$

$$s_2 = 250.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 555.55$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 441.5397$$

$$fy_1 = 367.9498$$

$$su_1 = 0.00512$$

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

```

Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 367.9498
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 441.5397
fy2 = 367.9498
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 367.9498
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04735912
2 = Asl,com/(b*d)*(fs2/fc) = 0.04735912
v = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05619999
2 = Asl,com/(b*d)*(fs2/fc) = 0.05619999
v = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.16690234
Mu = MRc (4.14) = 1.7252E+008
u = su (4.1) = 1.7214953E-005

```

Calculation of ratio lb/ld

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 600261.003$

Calculation of Shear Strength at edge 1, $V_{r1} = 600261.003$

$V_{r1} = V_{\text{Col}} ((10.3), \text{ASCE } 41-17) = k_n l^* V_{\text{ColO}}$

$V_{\text{ColO}} = 600261.003$

$k_n l = 1$ (zero step-static loading)

NOTE: In expression (10-3) ' $V_s = A_v f_y d/s$ ' is replaced by ' $V_s + f^* V_f$ ' where V_f is the contribution of FRPs (11.3), ACI 440).

$= 1$ (normal-weight concrete)

Mean concrete strength: $f_c' = (f_c'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f_c'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 28.23333$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$M/Vd = 2.00$

$\mu_u = 1.0002017\text{E}-011$

$\nu_u = 1.3927229\text{E}-031$

$d = 0.8 \cdot h = 320.00$

$N_u = 11016.808$

$A_g = 300000.00$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} = 279254.914$

where:

$V_{s1} = 279254.914$ is calculated for jacket, with:

$d = 320.00$

$A_v = 157079.633$

$f_y = 555.56$

$s = 100.00$

V_{s1} is multiplied by $\text{Col1} = 1.00$

$s/d = 0.3125$

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

$d = 160.00$

$A_v = 100530.965$

$f_y = 444.44$

$s = 250.00$

V_{s2} is multiplied by $\text{Col2} = 0.00$

$s/d = 1.5625$

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

From (11-11), ACI 440: $V_s + V_f \leq 847147.582$

$b_w = 750.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 600261.003$

$V_{r2} = V_{\text{Col}} ((10.3), \text{ASCE } 41-17) = k_n l^* V_{\text{ColO}}$

$V_{\text{ColO}} = 600261.003$

$k_n l = 1$ (zero step-static loading)

NOTE: In expression (10-3) ' $V_s = A_v f_y d/s$ ' is replaced by ' $V_s + f^* V_f$ ' where V_f is the contribution of FRPs (11.3), ACI 440).

$= 1$ (normal-weight concrete)

Mean concrete strength: $f_c' = (f_c'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f_c'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 28.23333$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$M/Vd = 2.00$

$\mu_u = 1.0002017\text{E}-011$

$\nu_u = 1.3927229\text{E}-031$

$d = 0.8 \cdot h = 320.00$

$N_u = 11016.808$

$A_g = 300000.00$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} = 279254.914$

where:

$V_{s1} = 279254.914$ is calculated for jacket, with:

$d = 320.00$

$A_v = 157079.633$

$f_y = 555.56$
 $s = 100.00$
 Vs1 is multiplied by Col1 = 1.00
 $s/d = 0.3125$
 Vs2 = 0.00 is calculated for core, with:
 $d = 160.00$
 $A_v = 100530.965$
 $f_y = 444.44$
 $s = 250.00$
 Vs2 is multiplied by Col2 = 0.00
 $s/d = 1.5625$
 $V_f ((11-3)-(11.4), \text{ACI } 440) = 0.00$
 From (11-11), ACI 440: $V_s + V_f \leq 847147.582$
 $b_w = 750.00$

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

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

Constant Properties

 Knowledge Factor, $\phi = 1.00$
 Mean strength values are used for both shear and moment calculations.
 Consequently:
 Jacket
 New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
 New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.56$
 Concrete Elasticity, $E_c = 26999.444$
 Steel Elasticity, $E_s = 200000.00$
 Existing Column
 Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 20.00$
 Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 444.44$
 Concrete Elasticity, $E_c = 21019.039$
 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, $f_s = 1.25 \cdot f_{sm} = 694.45$
 Existing Column
 Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 555.55$
 #####
 External Height, $H = 400.00$
 External Width, $W = 750.00$
 Internal Height, $H = 200.00$
 Internal Width, $W = 550.00$
 Cover Thickness, $c = 25.00$
 Mean Confinement Factor overall section = 1.00
 Element Length, $L = 3000.00$
 Secondary Member
 Ribbed Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Inadequate Lap Length with $l_o/l_{ou, \min} = 0.30$
 No FRP Wrapping

Stepwise Properties

Calculation of Shear Capacity ratio , $V_e/V_r = 0.25537128$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 235770.47$
 with
 $M_{pr1} = \text{Max}(M_{u1+} , M_{u1-}) = 3.5366\text{E}+008$
 $M_{u1+} = 3.5366\text{E}+008$, 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
 $M_{u1-} = 3.5366\text{E}+008$, 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
 $M_{pr2} = \text{Max}(M_{u2+} , M_{u2-}) = 3.5366\text{E}+008$
 $M_{u2+} = 3.5366\text{E}+008$, 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
 $M_{u2-} = 3.5366\text{E}+008$, 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

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:
 $\mu = 8.5738376E-006$
 $M_u = 3.5366E+008$

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$psh_x \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 1.60339$
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.0020944$
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$
 No stirups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00026808$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 No stirups, $ns_2 = 2.00$
 $h2 = 200.00$

$psh_y \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 3.13667$
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00392699$
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$
 No stirups, $ns_1 = 2.00$
 $h1 = 750.00$
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00073723$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 No stirups, $ns_2 = 2.00$
 $h2 = 550.00$

$Asec = 300000.00$

$s1 = 100.00$

$s2 = 250.00$

$fywe1 = 694.45$

$fywe2 = 555.55$

$fce = 33.00$

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

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

$y1 = 0.00140044$

$sh1 = 0.0044814$

$ft1 = 441.5397$

$fy1 = 367.9498$

$su1 = 0.00512$

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

$lo/lou, \min = lb/ld = 0.30$

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

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 $fs1 = (fs_jacket \cdot Asl, \text{ten, jacket} + fs_core \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 367.9498$

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

$y2 = 0.00140044$

$sh2 = 0.0044814$

$ft2 = 441.5397$

$fy2 = 367.9498$

$su2 = 0.00512$

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

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

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

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 $fs2 = (fs_jacket \cdot Asl, \text{com, jacket} + fs_core \cdot Asl, \text{com, core}) / Asl, \text{com} = 367.9498$

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

$yv = 0.00140044$

$shv = 0.0044814$

$ftv = 466.8167$

$fyv = 389.0139$

$suv = 0.00512$

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

and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.30$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and 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 $fsv = (fs_{jacket} * A_{sl,mid,jacket} + fs_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 389.0139$
 with $Esv = (Es_{jacket} * A_{sl,mid,jacket} + Es_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$
 $1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.04483877$
 $2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.04483877$
 $v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.01676222$
 and confined core properties:
 $b = 340.00$
 $d = 677.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.05508907$
 $2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.05508907$
 $v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.02059413$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.1553529$
 $Mu = MRc (4.14) = 3.5366E+008$
 $u = su (4.1) = 8.5738376E-006$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Mu_1 -

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

$u = 8.5738376E-006$
 $Mu = 3.5366E+008$

with full section properties:

$b = 400.00$
 $d = 707.00$
 $d' = 43.00$
 $v = 0.00118049$
 $N = 11016.808$
 $fc = 33.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0052143$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.0052143$
 $we (5.4c) = 0.00183676$
 $ase ((5.4d), TBDY) = (ase_1 * A_{ext} + ase_2 * A_{int}) / A_{sec} = 0.12601038$
 $ase_1 = 0.12601038$
 $bo_1 = 690.00$
 $ho_1 = 340.00$
 $bi_2_1 = 1.1834E+006$
 $ase_2 = \text{Max}(ase_1, ase_2) = 0.12601038$
 $bo_2 = 542.00$

$ho_2 = 192.00$
 $bi2_2 = 661256.00$
 $psh,min*Fywe = \text{Min}(psh,x*Fywe, psh,y*Fywe) = 1.60339$
 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)

$psh_x*Fywe = psh1*Fywe1 + ps2*Fywe2 = 1.60339$
 $ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.0020944$
 $Ash1 = Astir_1*ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00026808$
 $Ash2 = Astir_2*ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

$psh_y*Fywe = psh1*Fywe1 + ps2*Fywe2 = 3.13667$
 $ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00392699$
 $Ash1 = Astir_1*ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 750.00$
 $ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00073723$
 $Ash2 = Astir_2*ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 550.00$

$Asec = 300000.00$
 $s1 = 100.00$
 $s2 = 250.00$
 $fywe1 = 694.45$
 $fywe2 = 555.55$
 $fce = 33.00$

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

$y1 = 0.00140044$
 $sh1 = 0.0044814$
 $ft1 = 441.5397$
 $fy1 = 367.9498$
 $su1 = 0.00512$

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

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

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

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 $fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 367.9498$

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

$y2 = 0.00140044$
 $sh2 = 0.0044814$
 $ft2 = 441.5397$
 $fy2 = 367.9498$
 $su2 = 0.00512$

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

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

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

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 $fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 367.9498$

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

$yv = 0.00140044$

```

shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/ld = 0.30
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.04483877
    2 = Asl,com/(b*d)*(fs2/fc) = 0.04483877
    v = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.05508907
    2 = Asl,com/(b*d)*(fs2/fc) = 0.05508907
    v = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.1553529
Mu = MRc (4.14) = 3.5366E+008
u = su (4.1) = 8.5738376E-006

```

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

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

```

u = 8.5738376E-006
Mu = 3.5366E+008

```

with full section properties:

```

b = 400.00
d = 707.00
d' = 43.00
v = 0.00118049
N = 11016.808
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.0052143
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0052143
we (5.4c) = 0.00183676
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.12601038
ase1 = 0.12601038

```

$bo_1 = 690.00$
 $ho_1 = 340.00$
 $bi2_1 = 1.1834E+006$
 $ase2 = \text{Max}(ase1, ase2) = 0.12601038$
 $bo_2 = 542.00$
 $ho_2 = 192.00$
 $bi2_2 = 661256.00$
 $psh, min * Fywe = \text{Min}(psh, x * Fywe, psh, y * Fywe) = 1.60339$
 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)

$psh_x * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 1.60339$
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.0020944$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00026808$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

$psh_y * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 3.13667$
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.00392699$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 750.00$
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00073723$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 550.00$

$Asec = 300000.00$
 $s1 = 100.00$
 $s2 = 250.00$
 $fywe1 = 694.45$
 $fywe2 = 555.55$
 $fce = 33.00$
 From ((5.A5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$
 $y1 = 0.00140044$
 $sh1 = 0.0044814$
 $ft1 = 441.5397$
 $fy1 = 367.9498$
 $su1 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00
 $lo/lou, min = lb/l_d = 0.30$
 $su1 = 0.4 * esu1_nominal \text{ ((5.5), TBDY)} = 0.032$
 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 $fs1 = (fs, jacket * Asl, ten, jacket + fs, core * Asl, ten, core) / Asl, ten = 367.9498$
 with $Es1 = (Es, jacket * Asl, ten, jacket + Es, core * Asl, ten, core) / Asl, ten = 200000.00$
 $y2 = 0.00140044$
 $sh2 = 0.0044814$
 $ft2 = 441.5397$
 $fy2 = 367.9498$
 $su2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00
 $lo/lou, min = lb/l_b, min = 0.30$
 $su2 = 0.4 * esu2_nominal \text{ ((5.5), TBDY)} = 0.032$
 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 $f_{s2} = (f_{sjacket} \cdot A_{sl,com,jacket} + f_{s,core} \cdot A_{sl,com,core}) / A_{sl,com} = 367.9498$
 with $E_{s2} = (E_{sjacket} \cdot A_{sl,com,jacket} + E_{s,core} \cdot A_{sl,com,core}) / A_{sl,com} = 200000.00$
 $y_v = 0.00140044$
 $sh_v = 0.0044814$
 $ft_v = 466.8167$
 $fy_v = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.30$
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$
 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 $f_{sv} = (f_{sjacket} \cdot A_{sl,mid,jacket} + f_{s,mid} \cdot A_{sl,mid,core}) / A_{sl,mid} = 389.0139$
 with $E_{sv} = (E_{sjacket} \cdot A_{sl,mid,jacket} + E_{s,mid} \cdot A_{sl,mid,core}) / A_{sl,mid} = 200000.00$
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.04483877$
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.04483877$
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.01676222$
 and confined core properties:
 $b = 340.00$
 $d = 677.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.05508907$
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.05508907$
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.02059413$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.1553529$
 $Mu = MR_c (4.14) = 3.5366E+008$
 $u = su (4.1) = 8.5738376E-006$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Mu_2 -

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

$u = 8.5738376E-006$
 $Mu = 3.5366E+008$

with full section properties:

$b = 400.00$
 $d = 707.00$
 $d' = 43.00$
 $v = 0.00118049$
 $N = 11016.808$
 $f_c = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 Final value of ϕ_u : $\phi_u^* = \text{shear_factor} \cdot \text{Max}(\phi_u, cc) = 0.0052143$

The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $c_u = 0.0052143$
 we (5.4c) = 0.00183676
 $ase((5.4d), TBDY) = (ase1 \cdot A_{ext} + ase2 \cdot A_{int}) / A_{sec} = 0.12601038$
 $ase1 = 0.12601038$
 $bo_1 = 690.00$
 $ho_1 = 340.00$
 $bi2_1 = 1.1834E+006$
 $ase2 = \text{Max}(ase1, ase2) = 0.12601038$
 $bo_2 = 542.00$
 $ho_2 = 192.00$
 $bi2_2 = 661256.00$
 $psh, \min \cdot F_{ywe} = \text{Min}(psh, x \cdot F_{ywe}, psh, y \cdot F_{ywe}) = 1.60339$
 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)

$psh, x \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 1.60339$
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / A_{sec} = 0.0020944$
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / A_{sec} = 0.00026808$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

$psh, y \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 3.13667$
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / A_{sec} = 0.00392699$
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 750.00$
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / A_{sec} = 0.00073723$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 550.00$

$A_{sec} = 300000.00$
 $s1 = 100.00$
 $s2 = 250.00$
 $fywe1 = 694.45$
 $fywe2 = 555.55$
 $f_{ce} = 33.00$

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

$y1 = 0.00140044$
 $sh1 = 0.0044814$

$ft1 = 441.5397$

$fy1 = 367.9498$

$su1 = 0.00512$

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

$lo/lo, \min = lb/ld = 0.30$

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

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 $fs1 = (fs, \text{jacket} \cdot A_{sl, \text{ten, jacket}} + fs, \text{core} \cdot A_{sl, \text{ten, core}}) / A_{sl, \text{ten}} = 367.9498$

with $Es1 = (Es, \text{jacket} \cdot A_{sl, \text{ten, jacket}} + Es, \text{core} \cdot A_{sl, \text{ten, core}}) / A_{sl, \text{ten}} = 200000.00$

$y2 = 0.00140044$

$sh2 = 0.0044814$

$ft2 = 441.5397$

$fy2 = 367.9498$

$su2 = 0.00512$

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

$\text{Shear_factor} = 1.00$
 $\text{lo/lou,min} = \text{lb/lb,min} = 0.30$
 $\text{su}_2 = 0.4 \cdot \text{esu}_2\text{nominal} ((5.5), \text{TBDY}) = 0.032$
 From table 5A.1, TBDY: $\text{esu}_2\text{nominal} = 0.08$,
 For calculation of $\text{esu}_2\text{nominal}$ and $y_2, \text{sh}_2, \text{ft}_2, \text{fy}_2$, it is considered
 characteristic value $\text{fsy}_2 = \text{fs}_2/1.2$, from table 5.1, TBDY.
 $y_1, \text{sh}_1, \text{ft}_1, \text{fy}_1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.
 with $\text{fs}_2 = (\text{fs}_{\text{jacket}} \cdot \text{Asl,com,jacket} + \text{fs}_{\text{core}} \cdot \text{Asl,com,core}) / \text{Asl,com} = 367.9498$
 with $\text{Es}_2 = (\text{Es}_{\text{jacket}} \cdot \text{Asl,com,jacket} + \text{Es}_{\text{core}} \cdot \text{Asl,com,core}) / \text{Asl,com} = 200000.00$
 $y_v = 0.00140044$
 $\text{sh}_v = 0.0044814$
 $\text{ft}_v = 466.8167$
 $\text{fy}_v = 389.0139$
 $\text{su}_v = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $\text{lo/lou,min} = \text{lb}/\text{ld} = 0.30$
 $\text{su}_v = 0.4 \cdot \text{esuv_nominal} ((5.5), \text{TBDY}) = 0.032$
 From table 5A.1, TBDY: $\text{esuv_nominal} = 0.08$,
 considering characteristic value $\text{fsy}_v = \text{fs}_v/1.2$, from table 5.1, TBDY
 For calculation of esuv_nominal and $y_v, \text{sh}_v, \text{ft}_v, \text{fy}_v$, it is considered
 characteristic value $\text{fsy}_v = \text{fs}_v/1.2$, from table 5.1, TBDY.
 $y_1, \text{sh}_1, \text{ft}_1, \text{fy}_1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.
 with $\text{fs}_v = (\text{fs}_{\text{jacket}} \cdot \text{Asl,mid,jacket} + \text{fs}_{\text{mid}} \cdot \text{Asl,mid,core}) / \text{Asl,mid} = 389.0139$
 with $\text{Es}_v = (\text{Es}_{\text{jacket}} \cdot \text{Asl,mid,jacket} + \text{Es}_{\text{mid}} \cdot \text{Asl,mid,core}) / \text{Asl,mid} = 200000.00$
 $1 = \text{Asl,ten}/(\text{b} \cdot \text{d}) \cdot (\text{fs}_1/\text{fc}) = 0.04483877$
 $2 = \text{Asl,com}/(\text{b} \cdot \text{d}) \cdot (\text{fs}_2/\text{fc}) = 0.04483877$
 $v = \text{Asl,mid}/(\text{b} \cdot \text{d}) \cdot (\text{fs}_v/\text{fc}) = 0.01676222$
 and confined core properties:
 $b = 340.00$
 $d = 677.00$
 $d' = 13.00$
 $\text{fcc} (5A.2, \text{TBDY}) = 33.00$
 $\text{cc} (5A.5, \text{TBDY}) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = \text{Asl,ten}/(\text{b} \cdot \text{d}) \cdot (\text{fs}_1/\text{fc}) = 0.05508907$
 $2 = \text{Asl,com}/(\text{b} \cdot \text{d}) \cdot (\text{fs}_2/\text{fc}) = 0.05508907$
 $v = \text{Asl,mid}/(\text{b} \cdot \text{d}) \cdot (\text{fs}_v/\text{fc}) = 0.02059413$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

Calculation of ratio lb/ld

Inadequate Lap Length with $\text{lb}/\text{ld} = 0.30$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 923245.821$

Calculation of Shear Strength at edge 1, $V_{r1} = 923245.821$

$V_{r1} = V_{\text{Col}} ((10.3), \text{ASCE 41-17}) = \text{knl} \cdot V_{\text{ColO}}$

$V_{\text{ColO}} = 923245.821$

$\text{knl} = 1$ (zero step-static loading)

NOTE: In expression (10-3) ' $V_s = A_v \cdot \text{fy} \cdot \text{d}/s$ ' is replaced by ' $V_s + f \cdot V_f$ '
 where V_f is the contribution of FRPs (11.3), ACI 440).

$= 1$ (normal-weight concrete)

Mean concrete strength: $f_c' = (f_c'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f_c'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 28.23333$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$M/Vd = 2.00$

$\mu_u = 6.8236829\text{E-}012$

$\mu_v = 3.9443045\text{E-}031$

$d = 0.8 \cdot h = 600.00$

$N_u = 11016.808$

$A_g = 300000.00$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} = 602239.733$

where:

$V_{s1} = 523602.964$ is calculated for jacket, with:

$d = 600.00$

$A_v = 157079.633$

$f_y = 555.56$

$s = 100.00$

V_{s1} is multiplied by $\text{Col1} = 1.00$

$s/d = 0.16666667$

$V_{s2} = 78636.768$ is calculated for core, with:

$d = 440.00$

$A_v = 100530.965$

$f_y = 444.44$

$s = 250.00$

V_{s2} is multiplied by $\text{Col2} = 1.00$

$s/d = 0.56818182$

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

From (11-11), ACI 440: $V_s + V_f \leq 847147.582$

$b_w = 400.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 923245.821$

$V_{r2} = V_{\text{Col}} ((10.3), \text{ASCE } 41-17) = k_{nl} \cdot V_{\text{ColO}}$

$V_{\text{ColO}} = 923245.821$

$k_{nl} = 1$ (zero step-static loading)

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

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

= 1 (normal-weight concrete)

Mean concrete strength: $f_c' = (f_c'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f_c'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 28.23333$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$M/Vd = 2.00$

$\mu_u = 6.8236829\text{E-}012$

$\mu_v = 3.9443045\text{E-}031$

$d = 0.8 \cdot h = 600.00$

$N_u = 11016.808$

$A_g = 300000.00$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} = 602239.733$

where:

$V_{s1} = 523602.964$ is calculated for jacket, with:

$d = 600.00$

$A_v = 157079.633$

$f_y = 555.56$

$s = 100.00$

V_{s1} is multiplied by $\text{Col1} = 1.00$

$s/d = 0.16666667$

$V_{s2} = 78636.768$ is calculated for core, with:

$d = 440.00$

$A_v = 100530.965$

$f_y = 444.44$

$s = 250.00$

V_{s2} is multiplied by $\text{Col2} = 1.00$

$s/d = 0.56818182$

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

From (11-11), ACI 440: $V_s + V_f \leq 847147.582$

$b_w = 400.00$

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

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

Constant Properties

Knowledge Factor, $\gamma = 1.00$
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, $f_c = f_{cm} = 33.00$
New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.56$
Concrete Elasticity, $E_c = 26999.444$
Steel Elasticity, $E_s = 200000.00$
Existing Column
Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 20.00$
Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 444.44$
Concrete Elasticity, $E_c = 21019.039$
Steel Elasticity, $E_s = 200000.00$
External Height, $H = 400.00$
External Width, $W = 750.00$
Internal Height, $H = 200.00$
Internal Width, $W = 550.00$
Cover Thickness, $c = 25.00$
Element Length, $L = 3000.00$
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with $l_b/l_d = 0.30$
No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 2.2170426E-011$
Shear Force, $V_2 = 3386.997$
Shear Force, $V_3 = 3.7626771E-013$
Axial Force, $F = -16097.112$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{sl,t} = 0.00$
-Compression: $A_{sl,c} = 2676.637$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{sl,ten} = 1137.257$
-Compression: $A_{sl,com} = 1137.257$
-Middle: $A_{sl,mid} = 402.1239$
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{sl,ten,jacket} = 829.3805$
-Compression: $A_{sl,com,jacket} = 829.3805$
-Middle: $A_{sl,mid,jacket} = 402.1239$
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{sl,ten,core} = 307.8761$
-Compression: $A_{sl,com,core} = 307.8761$
-Middle: $A_{sl,mid,core} = 0.00$
Mean Diameter of Tension Reinforcement, $DbL = 16.80$

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = u = 0.00198322$
 $u = y + p = 0.00198322$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.00198322$ ((4.29), Biskinis Phd))
 $M_y = 1.2590E+008$
 $L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 1500.00
From table 10.5, ASCE 41_17: $E_{eff} = factor * E_c * I_g = 3.1741E+013$
 $factor = 0.30$
 $A_g = 300000.00$
Mean concrete strength: $f_c' = (f_c'_{jacket} * Area_{jacket} + f_c'_{core} * Area_{core}) / Area_{section} = 28.23333$
 $N = 16097.112$
 $E_c * I_g = E_{c,jacket} * I_{g,jacket} + E_{c,core} * I_{g,core} = 1.0580E+014$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

$y = \min(y_{ten}, y_{com})$
 $y_{ten} = 5.3808581E-006$
with ((10.1), ASCE 41-17) $f_y = \min(f_y, 1.25 * f_y * (I_b / I_d)^{2/3}) = 296.8915$
 $d = 357.00$
 $y = 0.22723402$
 $A = 0.01019927$
 $B = 0.00580293$
with $p_t = 0.00424746$
 $p_c = 0.00424746$
 $p_v = 0.00150186$
 $N = 16097.112$
 $b = 750.00$
 $\alpha = 0.12044818$
 $y_{comp} = 2.7496413E-005$
with $f_c = 33.00$
 $E_c = 26999.444$
 $y = 0.22412348$
 $A = 0.00986014$
 $B = 0.00560044$
with $E_s = 200000.00$

Calculation of ratio I_b / I_d

Inadequate Lap Length with $I_b / I_d = 0.30$

- Calculation of p -

From table 10-8: $p = 0.00$

with:

- Columns controlled by inadequate development or splicing along the clear height because $I_b / I_d < 1$
shear control ratio $V_y E / V_{col} E = 0.19160863$
 $d = d_{external} = 357.00$
 $s = s_{external} = 0.00$
 $t = s_1 + s_2 + 2 * t_f / b_w * (f_{fe} / f_s) = 0.00236248$
jacket: $s_1 = A_{v1} * h_1 / (s_1 * A_g) = 0.0020944$
 $A_{v1} = 157.0796$, is the total area of all stirrups parallel to loading (shear) direction
 $h_1 = 400.00$
 $s_1 = 100.00$
core: $s_2 = A_{v2} * h_2 / (s_2 * A_g) = 0.00026808$
 $A_{v2} = 100.531$, is the total area of all stirrups parallel to loading (shear) direction
 $h_2 = 200.00$

$$s2 = 250.00$$

The term $2 \cdot t_f / b_w \cdot (f_{fe} / f_s)$ is implemented to account for FRP contribution where $f = 2 \cdot t_f / b_w$ is FRP ratio (EC8 - 3, A.4.4.3(6)) and f_{fe} / f_s normalises f to steel strength. All these variables have already been given in Shear control ratio calculation. For the normalisation f_s of jacket is used.

$$NUD = 16097.112$$

$$A_g = 300000.00$$

$$f_{cE} = (f_{c_jacket} \cdot Area_jacket + f_{c_core} \cdot Area_core) / section_area = 28.23333$$

$$f_{yE} = (f_{y_ext_Long_Reinf} \cdot Area_ext_Long_Reinf + f_{y_int_Long_Reinf} \cdot Area_int_Long_Reinf) / Area_Tot_Long_Rein = 529.9972$$

$$f_{ytE} = (f_{y_ext_Trans_Reinf} \cdot s1 + f_{y_int_Trans_Reinf} \cdot s2) / (s1 + s2) = 542.9506$$

$$\rho_l = Area_Tot_Long_Rein / (b \cdot d) = 0.00999678$$

$$b = 750.00$$

$$d = 357.00$$

$$f_{cE} = 28.23333$$

End Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1

At local axis: 2

Integration Section: (b)

Calculation No. 7

column C1, Floor 1

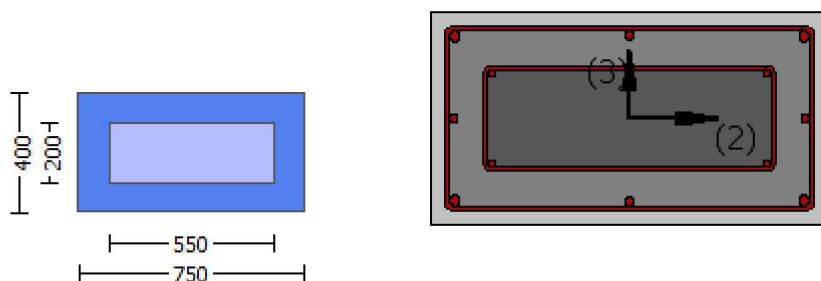
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: End

Local Axis: (3)



Start Of Calculation of Shear Capacity for element: column JC1 of floor 1

At local axis: 3

Integration Section: (b)

Section Type: rcjrs

Constant Properties

Knowledge Factor, $\phi = 1.00$
 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, $f_c = f_{c_lower_bound} = 25.00$
 New material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$
 Concrete Elasticity, $E_c = 26999.444$
 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, $f_s = f_{s_lower_bound} = 400.00$
 Concrete Elasticity, $E_c = 21019.039$
 Steel Elasticity, $E_s = 200000.00$
 #####
 Note: Especially for the calculation of γ for displacement ductility demand,
 the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as
 Deformation-Controlled Action (Table C7-1, ASCE 41-17).
 Jacket
 New material: Concrete Strength, $f_c = f_{cm} = 33.00$
 New material: Steel Strength, $f_s = f_{sm} = 555.56$
 Existing Column
 Existing material: Concrete Strength, $f_c = f_{cm} = 20.00$
 Existing material: Steel Strength, $f_s = f_{sm} = 444.44$
 #####
 External Height, $H = 400.00$
 External Width, $W = 750.00$
 Internal Height, $H = 200.00$
 Internal Width, $W = 550.00$
 Cover Thickness, $c = 25.00$
 Element Length, $L = 3000.00$
 Secondary Member
 Ribbed Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Inadequate Lap Length with $l_o/l_{ou,min} = l_b/l_d = 0.30$
 No FRP Wrapping

Stepwise Properties

EDGE -A-
 Bending Moment, $M_a = 1.1088903E-009$
 Shear Force, $V_a = -3.7626771E-013$
 EDGE -B-
 Bending Moment, $M_b = 2.2170426E-011$
 Shear Force, $V_b = 3.7626771E-013$
 BOTH EDGES
 Axial Force, $F = -16097.112$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $A_{st} = 0.00$
 -Compression: $A_{sc} = 2676.637$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $A_{st,ten} = 1137.257$
 -Compression: $A_{sc,com} = 1137.257$
 -Middle: $A_{st,mid} = 402.1239$
 Mean Diameter of Tension Reinforcement, $D_{bL,ten} = 16.80$

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = \phi V_n = 534028.057$
 $V_n ((10.3), ASCE 41-17) = knl * V_{ColO} = 534028.057$
 $V_{Col} = 534028.057$
 $knl = 1.00$

displacement_ductility_demand = 0.00

NOTE: In expression (10-3) ' $V_s = A_v \cdot f_y \cdot d / s$ ' is replaced by ' $V_s + f \cdot V_f$ ' where V_f is the contribution of FRPs (11.3), ACI 440).

= 1 (normal-weight concrete)

Mean concrete strength: $f_c' = (f_c'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f_c'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 21.70$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$M/Vd = 2.00$

$\mu_u = 2.2170426E-011$

$\nu_u = 3.7626771E-013$

$d = 0.8 \cdot h = 320.00$

$N_u = 16097.112$

$A_g = 300000.00$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} = 251327.412$

where:

$V_{s1} = 251327.412$ is calculated for jacket, with:

$d = 320.00$

$A_v = 157079.633$

$f_y = 500.00$

$s = 100.00$

V_{s1} is multiplied by $\text{Col1} = 1.00$

$s/d = 0.3125$

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

$d = 160.00$

$A_v = 100530.965$

$f_y = 400.00$

$s = 250.00$

V_{s2} is multiplied by $\text{Col2} = 0.00$

$s/d = 1.5625$

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

From (11-11), ACI 440: $V_s + V_f \leq 742690.493$

$b_w = 750.00$

displacement_ductility_demand is calculated as ϕ / y

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

From analysis, chord rotation $\phi = 4.8420344E-021$

$y = (M_y \cdot L_s / 3) / E_{\text{eff}} = 0.00198322$ ((4.29), Biskinis Phd))

$M_y = 1.2590E+008$

$L_s = M/V$ (with $L_s > 0.1 \cdot L$ and $L_s < 2 \cdot L$) = 1500.00

From table 10.5, ASCE 41_17: $E_{\text{eff}} = \text{factor} \cdot E_c \cdot I_g = 3.1741E+013$

factor = 0.30

$A_g = 300000.00$

Mean concrete strength: $f_c' = (f_c'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f_c'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 28.23333$

$N = 16097.112$

$E_c \cdot I_g = E_{c_{\text{jacket}}} \cdot I_{g_{\text{jacket}}} + E_{c_{\text{core}}} \cdot I_{g_{\text{core}}} = 1.0580E+014$

Calculation of Yielding Moment M_y

Calculation of ϕ and M_y according to Annex 7 -

$y = \text{Min}(y_{\text{ten}}, y_{\text{com}})$

$y_{\text{ten}} = 5.3808581E-006$

with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25 \cdot f_y \cdot (I_b / I_d)^{2/3}) = 296.8915$

$d = 357.00$

$y = 0.22723402$

$A = 0.01019927$

$B = 0.00580293$

with $p_t = 0.00424746$

$p_c = 0.00424746$

$p_v = 0.00150186$
 $N = 16097.112$
 $b = 750.00$
 $" = 0.12044818$
 $y_{comp} = 2.7496413E-005$
 with $f_c = 33.00$
 $E_c = 26999.444$
 $y = 0.22412348$
 $A = 0.00986014$
 $B = 0.00560044$
 with $E_s = 200000.00$

Calculation of ratio I_b/I_d

Inadequate Lap Length with $I_b/I_d = 0.30$

End Of Calculation of Shear Capacity for element: column JC1 of floor 1

At local axis: 3

Integration Section: (b)

Calculation No. 8

column C1, Floor 1

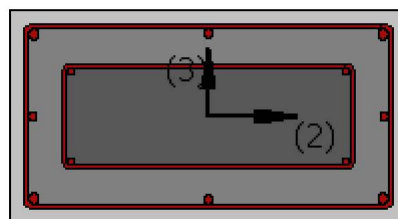
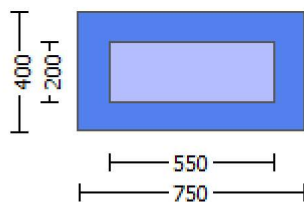
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (μ)

Edge: End

Local Axis: (3)



Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjrs

Constant Properties

Knowledge Factor, $\phi = 1.00$
 Mean strength values are used for both shear and moment calculations.
 Consequently:
 Jacket
 New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
 New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.56$
 Concrete Elasticity, $E_c = 26999.444$
 Steel Elasticity, $E_s = 200000.00$
 Existing Column
 Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 20.00$
 Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 444.44$
 Concrete Elasticity, $E_c = 21019.039$
 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, $f_s = 1.25 \cdot f_{sm} = 694.45$
 Existing Column
 Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 555.55$
 #####
 External Height, $H = 400.00$
 External Width, $W = 750.00$
 Internal Height, $H = 200.00$
 Internal Width, $W = 550.00$
 Cover Thickness, $c = 25.00$
 Mean Confinement Factor overall section = 1.00
 Element Length, $L = 3000.00$
 Secondary Member
 Ribbed Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Inadequate Lap Length with $l_o/l_{ou,min} = 0.30$
 No FRP Wrapping

Stepwise Properties

At local axis: 3
 EDGE -A-
 Shear Force, $V_a = -1.3927229E-031$
 EDGE -B-
 Shear Force, $V_b = 1.3927229E-031$
 BOTH EDGES
 Axial Force, $F = -11016.808$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $A_{sl,t} = 0.00$
 -Compression: $A_{sl,c} = 2676.637$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $A_{sl,ten} = 1137.257$
 -Compression: $A_{sl,com} = 1137.257$
 -Middle: $A_{sl,mid} = 402.1239$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.19160863$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 115015.186$
 with
 $M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 1.7252E+008$
 $M_{u1+} = 1.7252E+008$, 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
 $M_{u1-} = 1.7252E+008$, 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

$$M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 1.7252E+008$$

$M_{u2+} = 1.7252E+008$, 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

$M_{u2-} = 1.7252E+008$, 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

Calculation of M_{u1+}

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

$$\phi_u = 1.7214953E-005$$

$$M_u = 1.7252E+008$$

with full section properties:

$$b = 750.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00124684$$

$$N = 11016.808$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_{cu} = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.0052143$$

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

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.0052143$$

$$\phi_{we} (5.4c) = 0.00183676$$

$$\phi_{ase} ((5.4d), \text{TBDY}) = (\phi_{ase1} * A_{ext} + \phi_{ase2} * A_{int}) / A_{sec} = 0.12601038$$

$$\phi_{ase1} = 0.12601038$$

$$b_{o_1} = 690.00$$

$$h_{o_1} = 340.00$$

$$b_{i2_1} = 1.1834E+006$$

$$\phi_{ase2} = \text{Max}(\phi_{ase1}, \phi_{ase2}) = 0.12601038$$

$$b_{o_2} = 542.00$$

$$h_{o_2} = 192.00$$

$$b_{i2_2} = 661256.00$$

$$\phi_{psh, \min} * F_{ywe} = \text{Min}(\phi_{psh, x} * F_{ywe}, \phi_{psh, y} * F_{ywe}) = 1.60339$$

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)

$$\phi_{psh, x} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{ps2} * F_{ywe2} = 1.60339$$

$$\phi_{ps1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.0020944$$

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

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

$$h_1 = 400.00$$

$$\phi_{ps2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00026808$$

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

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

$$h_2 = 200.00$$

$$\phi_{psh, y} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{ps2} * F_{ywe2} = 3.13667$$

$$\phi_{ps1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00392699$$

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

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

$$h_1 = 750.00$$

$$\phi_{ps2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00073723$$

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

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

$$h_2 = 550.00$$

$$A_{sec} = 300000.00$$

$$s_1 = 100.00$$

$$s_2 = 250.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 555.55$$

$$f_{ce} = 33.00$$

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


```

c = confinement factor = 1.00
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 441.5397
fy1 = 367.9498
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 367.9498
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 441.5397
fy2 = 367.9498
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 367.9498
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04735912
2 = Asl,com/(b*d)*(fs2/fc) = 0.04735912
v = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05619999
2 = Asl,com/(b*d)*(fs2/fc) = 0.05619999
v = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied

```

```

--->
su (4.9) = 0.16690234
Mu = MRc (4.14) = 1.7252E+008
u = su (4.1) = 1.7214953E-005
-----

Calculation of ratio lb/ld
-----

Inadequate Lap Length with lb/ld = 0.30
-----

Calculation of Mu1-
-----

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 1.7214953E-005
Mu = 1.7252E+008
-----

with full section properties:
b = 750.00
d = 357.00
d' = 43.00
v = 0.00124684
N = 11016.808
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.0052143
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0052143
we (5.4c) = 0.00183676
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
bi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
bi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.60339
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 = 1.60339
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.13667
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00
-----

Asec = 300000.00
s1 = 100.00

```

$s_2 = 250.00$
 $f_{ywe1} = 694.45$
 $f_{ywe2} = 555.55$
 $f_{ce} = 33.00$
 From ((5A.5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$
 $y_1 = 0.00140044$
 $sh_1 = 0.0044814$
 $ft_1 = 441.5397$
 $fy_1 = 367.9498$
 $su_1 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou, \min = lb/ld = 0.30$
 $su_1 = 0.4 * esu_1 \text{ nominal } ((5.5), \text{TBDY}) = 0.032$
 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 $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_1 = (fs_{jacket} * Asl, \text{ten, jacket} + fs_{core} * Asl, \text{ten, core}) / Asl, \text{ten} = 367.9498$
 with $Es_1 = (Es_{jacket} * Asl, \text{ten, jacket} + Es_{core} * Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$
 $y_2 = 0.00140044$
 $sh_2 = 0.0044814$
 $ft_2 = 441.5397$
 $fy_2 = 367.9498$
 $su_2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou, \min = lb/lb, \min = 0.30$
 $su_2 = 0.4 * esu_2 \text{ nominal } ((5.5), \text{TBDY}) = 0.032$
 From table 5A.1, TBDY: $esu_2 \text{ nominal} = 0.08$,
 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, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = (fs_{jacket} * Asl, \text{com, jacket} + fs_{core} * Asl, \text{com, core}) / Asl, \text{com} = 367.9498$
 with $Es_2 = (Es_{jacket} * Asl, \text{com, jacket} + Es_{core} * Asl, \text{com, core}) / Asl, \text{com} = 200000.00$
 $y_v = 0.00140044$
 $sh_v = 0.0044814$
 $ft_v = 466.8167$
 $fy_v = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou, \min = lb/ld = 0.30$
 $suv = 0.4 * esuv \text{ nominal } ((5.5), \text{TBDY}) = 0.032$
 From table 5A.1, TBDY: $esuv \text{ nominal} = 0.08$,
 considering characteristic value $fsyv = fs_v/1.2$, from table 5.1, TBDY
 For calculation of $esuv \text{ nominal}$ 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 $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_v = (fs_{jacket} * Asl, \text{mid, jacket} + fs_{mid} * Asl, \text{mid, core}) / Asl, \text{mid} = 389.0139$
 with $Es_v = (Es_{jacket} * Asl, \text{mid, jacket} + Es_{mid} * Asl, \text{mid, core}) / Asl, \text{mid} = 200000.00$
 $1 = Asl, \text{ten} / (b * d) * (fs_1 / f_c) = 0.04735912$
 $2 = Asl, \text{com} / (b * d) * (fs_2 / f_c) = 0.04735912$
 $v = Asl, \text{mid} / (b * d) * (fs_v / f_c) = 0.01770442$
 and confined core properties:
 $b = 690.00$
 $d = 327.00$
 $d' = 13.00$
 $f_{cc} (5A.2, \text{TBDY}) = 33.00$
 $cc (5A.5, \text{TBDY}) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl, \text{ten} / (b * d) * (fs_1 / f_c) = 0.05619999$
 $2 = Asl, \text{com} / (b * d) * (fs_2 / f_c) = 0.05619999$

$v = A_{sl, mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.02100943$
Case/Assumption: Unconfined full section - Steel rupture
satisfies Eq. (4.3)

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

--->
 $\mu_u (4.9) = 0.16690234$
 $\mu_u = M_{Rc} (4.14) = 1.7252E+008$
 $u = \mu_u (4.1) = 1.7214953E-005$

Calculation of ratio I_b/I_d

Inadequate Lap Length with $I_b/I_d = 0.30$

Calculation of μ_{u2+}

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

$u = 1.7214953E-005$
 $\mu_u = 1.7252E+008$

with full section properties:

$b = 750.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.00124684$
 $N = 11016.808$
 $f_c = 33.00$
 $\alpha (5A.5, TBDY) = 0.002$
Final value of μ_{cu} : $\mu_{cu}^* = \text{shear_factor} \cdot \text{Max}(\mu_{cu}, \mu_{cc}) = 0.0052143$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $\mu_{cu} = 0.0052143$
 $\mu_{we} (5.4c) = 0.00183676$
 $\alpha_{se} ((5.4d), TBDY) = (\alpha_{se1} \cdot A_{ext} + \alpha_{se2} \cdot A_{int}) / A_{sec} = 0.12601038$
 $\alpha_{se1} = 0.12601038$
 $b_{o_1} = 690.00$
 $h_{o_1} = 340.00$
 $b_{i2_1} = 1.1834E+006$
 $\alpha_{se2} = \text{Max}(\alpha_{se1}, \alpha_{se2}) = 0.12601038$
 $b_{o_2} = 542.00$
 $h_{o_2} = 192.00$
 $b_{i2_2} = 661256.00$
 $\mu_{psh, min} \cdot F_{ywe} = \text{Min}(\mu_{psh, x} \cdot F_{ywe}, \mu_{psh, y} \cdot F_{ywe}) = 1.60339$

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

$\mu_{psh, x} \cdot F_{ywe} = \mu_{psh1} \cdot F_{ywe1} + \mu_{ps2} \cdot F_{ywe2} = 1.60339$
 $\mu_{ps1} \text{ (external)} = (A_{sh1} \cdot h_1 / s_1) / A_{sec} = 0.0020944$
 $A_{sh1} = A_{stir_1} \cdot n_{s_1} = 157.0796$
No stirrups, $n_{s_1} = 2.00$
 $h_1 = 400.00$
 $\mu_{ps2} \text{ (internal)} = (A_{sh2} \cdot h_2 / s_2) / A_{sec} = 0.00026808$
 $A_{sh2} = A_{stir_2} \cdot n_{s_2} = 100.531$
No stirrups, $n_{s_2} = 2.00$
 $h_2 = 200.00$

$\mu_{psh, y} \cdot F_{ywe} = \mu_{psh1} \cdot F_{ywe1} + \mu_{ps2} \cdot F_{ywe2} = 3.13667$
 $\mu_{ps1} \text{ (external)} = (A_{sh1} \cdot h_1 / s_1) / A_{sec} = 0.00392699$
 $A_{sh1} = A_{stir_1} \cdot n_{s_1} = 157.0796$
No stirrups, $n_{s_1} = 2.00$
 $h_1 = 750.00$
 $\mu_{ps2} \text{ (internal)} = (A_{sh2} \cdot h_2 / s_2) / A_{sec} = 0.00073723$
 $A_{sh2} = A_{stir_2} \cdot n_{s_2} = 100.531$

No stirrups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00

s1 = 100.00

s2 = 250.00

fywe1 = 694.45

fywe2 = 555.55

fce = 33.00

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

c = confinement factor = 1.00

y1 = 0.00140044

sh1 = 0.0044814

ft1 = 441.5397

fy1 = 367.9498

su1 = 0.00512

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

lo/lou,min = lb/ld = 0.30

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

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

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

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

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 367.9498

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

y2 = 0.00140044

sh2 = 0.0044814

ft2 = 441.5397

fy2 = 367.9498

su2 = 0.00512

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

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

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

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

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

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

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 367.9498

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

yv = 0.00140044

shv = 0.0044814

ftv = 466.8167

fyv = 389.0139

suv = 0.00512

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

lo/lou,min = lb/ld = 0.30

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

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

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

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

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

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

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

1 = Asl,ten/(b*d)*(fs1/fc) = 0.04735912

2 = Asl,com/(b*d)*(fs2/fc) = 0.04735912

v = Asl,mid/(b*d)*(fsv/fc) = 0.01770442

and confined core properties:

b = 690.00

d = 327.00

d' = 13.00

```

fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05619999
2 = Asl,com/(b*d)*(fs2/fc) = 0.05619999
v = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.16690234
Mu = MRc (4.14) = 1.7252E+008
u = su (4.1) = 1.7214953E-005

```

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

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

u = 1.7214953E-005

Mu = 1.7252E+008

with full section properties:

```

b = 750.00
d = 357.00
d' = 43.00
v = 0.00124684
N = 11016.808
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.0052143
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0052143
we (5.4c) = 0.00183676
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
bi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
bi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.60339
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 = 1.60339
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirrups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirrups, ns_2 = 2.00
h2 = 200.00

```

```

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.13667
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699

```

$Ash1 = Astir_1 * ns_1 = 157.0796$
 $No\ stirups, ns_1 = 2.00$
 $h1 = 750.00$
 $ps2\ (internal) = (Ash2 * h2 / s2) / Asec = 0.00073723$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 $No\ stirups, ns_2 = 2.00$
 $h2 = 550.00$

$Asec = 300000.00$
 $s1 = 100.00$
 $s2 = 250.00$
 $fywe1 = 694.45$
 $fywe2 = 555.55$
 $fce = 33.00$

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

$y1 = 0.00140044$
 $sh1 = 0.0044814$
 $ft1 = 441.5397$
 $fy1 = 367.9498$
 $su1 = 0.00512$

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

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

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

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

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

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

with $fs1 = (fs,jacket * Asl,ten,jacket + fs,core * Asl,ten,core) / Asl,ten = 367.9498$

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

$y2 = 0.00140044$
 $sh2 = 0.0044814$

$ft2 = 441.5397$
 $fy2 = 367.9498$

$su2 = 0.00512$

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

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

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

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

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

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

with $fs2 = (fs,jacket * Asl,com,jacket + fs,core * Asl,com,core) / Asl,com = 367.9498$

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

$yv = 0.00140044$
 $shv = 0.0044814$

$ftv = 466.8167$
 $fyv = 389.0139$

$suv = 0.00512$

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

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

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

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

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

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

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

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

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

$1 = Asl,ten / (b * d) * (fs1 / fc) = 0.04735912$

$2 = Asl,com / (b * d) * (fs2 / fc) = 0.04735912$

$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.01770442$
 and confined core properties:
 $b = 690.00$
 $d = 327.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.05619999$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.05619999$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.02100943$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.16690234$
 $\mu = MR_c (4.14) = 1.7252E+008$
 $u = su (4.1) = 1.7214953E-005$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Shear Strength $V_r = \min(V_{r1}, V_{r2}) = 600261.003$

Calculation of Shear Strength at edge 1, $V_{r1} = 600261.003$

$V_{r1} = V_{Col} ((10.3), ASCE 41-17) = k_{nl} * V_{Col0}$
 $V_{Col0} = 600261.003$
 $k_{nl} = 1$ (zero step-static loading)

NOTE: In expression (10-3) ' $V_s = A_v * f_y * d / s$ ' is replaced by ' $V_{s+} = f * V_f$ '
 where V_f is the contribution of FRPs (11.3), ACI 440).

$= 1$ (normal-weight concrete)
 Mean concrete strength: $f'_c = (f'_{c,jacket} * Area_{jacket} + f'_{c,core} * Area_{core}) / Area_{section} = 28.23333$, but $f_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $M/Vd = 2.00$
 $\mu_u = 1.0002017E-011$
 $V_u = 1.3927229E-031$
 $d = 0.8 * h = 320.00$
 $N_u = 11016.808$
 $A_g = 300000.00$
 From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} = 279254.914$
 where:
 $V_{s1} = 279254.914$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 555.56$
 $s = 100.00$
 V_{s1} is multiplied by $Col1 = 1.00$
 $s/d = 0.3125$
 $V_{s2} = 0.00$ is calculated for core, with:
 $d = 160.00$
 $A_v = 100530.965$
 $f_y = 444.44$
 $s = 250.00$
 V_{s2} is multiplied by $Col2 = 0.00$
 $s/d = 1.5625$
 $V_f ((11-3)-(11.4), ACI 440) = 0.00$
 From (11-11), ACI 440: $V_s + V_f \leq 847147.582$
 $bw = 750.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 600261.003$

$V_{r2} = V_{Col} ((10.3), ASCE 41-17) = knl * V_{Col0}$

$V_{Col0} = 600261.003$

$knl = 1$ (zero step-static loading)

NOTE: In expression (10-3) ' $V_s = A_v * f_y * d / s$ ' is replaced by ' $V_s + f * V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

$= 1$ (normal-weight concrete)

Mean concrete strength: $f_c' = (f_c'_{jacket} * Area_{jacket} + f_c'_{core} * Area_{core}) / Area_{section} = 28.23333$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$M / Vd = 2.00$

$\mu_u = 1.0002017E-011$

$\nu_u = 1.3927229E-031$

$d = 0.8 * h = 320.00$

$N_u = 11016.808$

$A_g = 300000.00$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} = 279254.914$

where:

$V_{s1} = 279254.914$ is calculated for jacket, with:

$d = 320.00$

$A_v = 157079.633$

$f_y = 555.56$

$s = 100.00$

V_{s1} is multiplied by $Col1 = 1.00$

$s/d = 0.3125$

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

$d = 160.00$

$A_v = 100530.965$

$f_y = 444.44$

$s = 250.00$

V_{s2} is multiplied by $Col2 = 0.00$

$s/d = 1.5625$

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

From (11-11), ACI 440: $V_s + V_f \leq 847147.582$

$bw = 750.00$

End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1

At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1

At Shear local axis: 2

(Bending local axis: 3)

Section Type: rcjrs

Constant Properties

Knowledge Factor, $= 1.00$

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

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 33.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.56$

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 20.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 444.44$

Concrete Elasticity, $E_c = 21019.039$

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,  $f_s = 1.25 \cdot f_{sm} = 694.45$ 
Existing Column
Existing material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 555.55$ 
#####
External Height,  $H = 400.00$ 
External Width,  $W = 750.00$ 
Internal Height,  $H = 200.00$ 
Internal Width,  $W = 550.00$ 
Cover Thickness,  $c = 25.00$ 
Mean Confinement Factor overall section = 1.00
Element Length,  $L = 3000.00$ 
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with  $l_o/l_{ou,min} = 0.30$ 
No FRP Wrapping
-----

Stepwise Properties
-----
At local axis: 2
EDGE -A-
Shear Force,  $V_a = -3.9443045E-031$ 
EDGE -B-
Shear Force,  $V_b = 3.9443045E-031$ 
BOTH EDGES
Axial Force,  $F = -11016.808$ 
Longitudinal Reinforcement Area Distribution (in 2 divisions)
  -Tension:  $As_t = 0.00$ 
  -Compression:  $As_c = 2676.637$ 
Longitudinal Reinforcement Area Distribution (in 3 divisions)
  -Tension:  $As_{t,ten} = 1137.257$ 
  -Compression:  $As_{l,com} = 1137.257$ 
  -Middle:  $As_{l,mid} = 402.1239$ 
-----
-----

Calculation of Shear Capacity ratio ,  $V_e/V_r = 0.25537128$ 
Member Controlled by Flexure ( $V_e/V_r < 1$ )
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n = 235770.47$ 
with
 $M_{pr1} = \text{Max}(\mu_{u1+} , \mu_{u1-}) = 3.5366E+008$ 
 $\mu_{u1+} = 3.5366E+008$ , 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
 $\mu_{u1-} = 3.5366E+008$ , 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
 $M_{pr2} = \text{Max}(\mu_{u2+} , \mu_{u2-}) = 3.5366E+008$ 
 $\mu_{u2+} = 3.5366E+008$ , 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
 $\mu_{u2-} = 3.5366E+008$ , is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination

-----
Calculation of  $\mu_{u1+}$ 
-----

-----
Calculation of ultimate curvature  $\phi_u$  according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 8.5738376E-006$ 
 $\mu_u = 3.5366E+008$ 
-----
with full section properties:

```

$b = 400.00$
 $d = 707.00$
 $d' = 43.00$
 $v = 0.00118049$
 $N = 11016.808$
 $f_c = 33.00$
 $\phi (5A.5, \text{TB DY}) = 0.002$
 Final value of ϕ : $\phi^* = \text{shear_factor} * \text{Max}(\phi, \phi_c) = 0.0052143$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TB DY: $\phi = 0.0052143$
 $\phi (5.4c) = 0.00183676$
 $\phi (5.4d), \text{TB DY} = (\phi_1 * A_{ext} + \phi_2 * A_{int}) / A_{sec} = 0.12601038$
 $\phi_1 = 0.12601038$
 $b_o_1 = 690.00$
 $h_o_1 = 340.00$
 $b_{i2_1} = 1.1834E+006$
 $\phi_2 = \text{Max}(\phi_1, \phi_2) = 0.12601038$
 $b_o_2 = 542.00$
 $h_o_2 = 192.00$
 $b_{i2_2} = 661256.00$
 $\phi_{sh, \min} * F_{ywe} = \text{Min}(\phi_{sh, x} * F_{ywe}, \phi_{sh, y} * F_{ywe}) = 1.60339$
 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)

$\phi_{sh, x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.60339$
 $\phi_{sh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.0020944$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h_1 = 400.00$
 $\phi_{sh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00026808$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirrups, $n_{s_2} = 2.00$
 $h_2 = 200.00$

$\phi_{sh, y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 3.13667$
 $\phi_{sh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00392699$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h_1 = 750.00$
 $\phi_{sh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00073723$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirrups, $n_{s_2} = 2.00$
 $h_2 = 550.00$

$A_{sec} = 300000.00$
 $s_1 = 100.00$
 $s_2 = 250.00$
 $f_{ywe1} = 694.45$
 $f_{ywe2} = 555.55$
 $f_{ce} = 33.00$
 From ((5.A5), TB DY), TB DY: $\phi_c = 0.002$
 $\phi_c = \text{confinement factor} = 1.00$
 $\phi_1 = 0.00140044$
 $\phi_{sh1} = 0.0044814$
 $\phi_{t1} = 441.5397$
 $\phi_{y1} = 367.9498$
 $\phi_{u1} = 0.00512$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $\phi_o / \phi_{ou, \min} = \phi_b / \phi_d = 0.30$
 $\phi_{u1} = 0.4 * \phi_{su1_nominal} ((5.5), \text{TB DY}) = 0.032$
 From table 5A.1, TB DY: $\phi_{su1_nominal} = 0.08$,
 For calculation of $\phi_{su1_nominal}$ and ϕ_{y1} , ϕ_{sh1} , ϕ_{t1} , ϕ_{y1} , it is considered
 characteristic value $\phi_{fs1} = \phi_{s1} / 1.2$, from table 5.1, TB DY.
 ϕ_{y1} , ϕ_{sh1} , ϕ_{t1} , ϕ_{y1} , are also multiplied by $\text{Min}(1, 1.25 * (\phi_b / \phi_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $\phi_{s1} = (\phi_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + \phi_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 367.9498$

```

with Es1 = (Esjacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 441.5397
fy2 = 367.9498
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 367.9498
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.30
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04483877
2 = Asl,com/(b*d)*(fs2/fc) = 0.04483877
v = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05508907
2 = Asl,com/(b*d)*(fs2/fc) = 0.05508907
v = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.1553529
Mu = MRc (4.14) = 3.5366E+008
u = su (4.1) = 8.5738376E-006

```

Calculation of ratio lb/lb

Inadequate Lap Length with lb/lb = 0.30

Calculation of Mu1-

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

$$\phi_u = 8.5738376E-006$$

$$M_u = 3.5366E+008$$

with full section properties:

$$b = 400.00$$

$$d = 707.00$$

$$d' = 43.00$$

$$v = 0.00118049$$

$$N = 11016.808$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.0052143$$

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

$$\text{From (5.4b), TBDY: } \phi_u = 0.0052143$$

$$\omega_e (5.4c) = 0.00183676$$

$$a_{se} ((5.4d), \text{TBDY}) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.12601038$$

$$a_{se1} = 0.12601038$$

$$b_{o_1} = 690.00$$

$$h_{o_1} = 340.00$$

$$b_{i2_1} = 1.1834E+006$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.12601038$$

$$b_{o_2} = 542.00$$

$$h_{o_2} = 192.00$$

$$b_{i2_2} = 661256.00$$

$$\text{psh_min} * F_{ywe} = \text{Min}(\text{psh_x} * F_{ywe}, \text{psh_y} * F_{ywe}) = 1.60339$$

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)

$$\text{psh_x} * F_{ywe} = \text{psh}_1 * F_{ywe1} + \text{ps}_2 * F_{ywe2} = 1.60339$$

$$\text{ps}_1 (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.0020944$$

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

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

$$h_1 = 400.00$$

$$\text{ps}_2 (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00026808$$

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

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

$$h_2 = 200.00$$

$$\text{psh_y} * F_{ywe} = \text{psh}_1 * F_{ywe1} + \text{ps}_2 * F_{ywe2} = 3.13667$$

$$\text{ps}_1 (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00392699$$

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

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

$$h_1 = 750.00$$

$$\text{ps}_2 (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00073723$$

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

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

$$h_2 = 550.00$$

$$A_{sec} = 300000.00$$

$$s_1 = 100.00$$

$$s_2 = 250.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 555.55$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 441.5397$$

$$fy_1 = 367.9498$$

$$su_1 = 0.00512$$

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

and also multiplied by the shear_factor according to 15.7.1.4, with

$$\text{Shear_factor} = 1.00$$

$$l_o / l_{ou, \text{min}} = l_b / l_d = 0.30$$

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

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 $fs1 = (fs_jacket \cdot Asl_ten_jacket + fs_core \cdot Asl_ten_core) / Asl_ten = 367.9498$
with $Es1 = (Es_jacket \cdot Asl_ten_jacket + Es_core \cdot Asl_ten_core) / Asl_ten = 200000.00$
 $y2 = 0.00140044$
 $sh2 = 0.0044814$
 $ft2 = 441.5397$
 $fy2 = 367.9498$
 $su2 = 0.00512$
using (30) in Biskinis/Fardis (2013) multiplied with $shear_factor$
and also multiplied by the $shear_factor$ according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou, min = lb/lb, min = 0.30$
 $su2 = 0.4 \cdot esu2_nominal \cdot ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esu2_nominal = 0.08$,
For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is 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 $fs2 = (fs_jacket \cdot Asl_com_jacket + fs_core \cdot Asl_com_core) / Asl_com = 367.9498$
with $Es2 = (Es_jacket \cdot Asl_com_jacket + Es_core \cdot Asl_com_core) / Asl_com = 200000.00$
 $yv = 0.00140044$
 $shv = 0.0044814$
 $ftv = 466.8167$
 $fyv = 389.0139$
 $suv = 0.00512$
using (30) in Biskinis/Fardis (2013) multiplied with $shear_factor$
and also multiplied by the $shear_factor$ according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou, min = lb/ld = 0.30$
 $suv = 0.4 \cdot esuv_nominal \cdot ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esuv_nominal = 0.08$,
considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is 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 $fsv = (fs_jacket \cdot Asl_mid_jacket + fs_mid \cdot Asl_mid_core) / Asl_mid = 389.0139$
with $Es_v = (Es_jacket \cdot Asl_mid_jacket + Es_mid \cdot Asl_mid_core) / Asl_mid = 200000.00$
 $1 = Asl_ten / (b \cdot d) \cdot (fs1 / fc) = 0.04483877$
 $2 = Asl_com / (b \cdot d) \cdot (fs2 / fc) = 0.04483877$
 $v = Asl_mid / (b \cdot d) \cdot (fsv / fc) = 0.01676222$
and confined core properties:
 $b = 340.00$
 $d = 677.00$
 $d' = 13.00$
 fcc (5A.2, TBDY) = 33.00
 cc (5A.5, TBDY) = 0.002
 $c = \text{confinement factor} = 1.00$
 $1 = Asl_ten / (b \cdot d) \cdot (fs1 / fc) = 0.05508907$
 $2 = Asl_com / (b \cdot d) \cdot (fs2 / fc) = 0.05508907$
 $v = Asl_mid / (b \cdot d) \cdot (fsv / fc) = 0.02059413$
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
 $v < vs, y2$ - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.1553529
 $Mu = MRc$ (4.14) = 3.5366E+008
 $u = su$ (4.1) = 8.5738376E-006

Calculation of ratio lb/ld

Inadequate Lap Length with $lb/ld = 0.30$

Calculation of Mu2+

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

$$\phi_u = 8.5738376E-006$$

$$M_u = 3.5366E+008$$

with full section properties:

$$b = 400.00$$

$$d = 707.00$$

$$d' = 43.00$$

$$v = 0.00118049$$

$$N = 11016.808$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.0052143$$

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

$$\text{From (5.4b), TBDY: } \phi_u = 0.0052143$$

$$\phi_{ue}(5.4c) = 0.00183676$$

$$\phi_{se}((5.4d), TBDY) = (\phi_{se1} * A_{ext} + \phi_{se2} * A_{int}) / A_{sec} = 0.12601038$$

$$\phi_{se1} = 0.12601038$$

$$b_{o_1} = 690.00$$

$$h_{o_1} = 340.00$$

$$\phi_{se2_1} = 1.1834E+006$$

$$\phi_{se2} = \text{Max}(\phi_{se1}, \phi_{se2}) = 0.12601038$$

$$b_{o_2} = 542.00$$

$$h_{o_2} = 192.00$$

$$\phi_{se2_2} = 661256.00$$

$$\phi_{sh, \min} * F_{ywe} = \text{Min}(\phi_{sh, x} * F_{ywe}, \phi_{sh, y} * F_{ywe}) = 1.60339$$

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)

$$\phi_{sh, x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.60339$$

$$\phi_{sh1}(\text{external}) = (\phi_{sh1} * h_1 / s_1) / A_{sec} = 0.0020944$$

$$\phi_{sh1} = \phi_{stir_1} * n_{s_1} = 157.0796$$

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

$$h_1 = 400.00$$

$$\phi_{sh2}(\text{internal}) = (\phi_{sh2} * h_2 / s_2) / A_{sec} = 0.00026808$$

$$\phi_{sh2} = \phi_{stir_2} * n_{s_2} = 100.531$$

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

$$h_2 = 200.00$$

$$\phi_{sh, y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 3.13667$$

$$\phi_{sh1}(\text{external}) = (\phi_{sh1} * h_1 / s_1) / A_{sec} = 0.00392699$$

$$\phi_{sh1} = \phi_{stir_1} * n_{s_1} = 157.0796$$

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

$$h_1 = 750.00$$

$$\phi_{sh2}(\text{internal}) = (\phi_{sh2} * h_2 / s_2) / A_{sec} = 0.00073723$$

$$\phi_{sh2} = \phi_{stir_2} * n_{s_2} = 100.531$$

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

$$h_2 = 550.00$$

$$A_{sec} = 300000.00$$

$$s_1 = 100.00$$

$$s_2 = 250.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 555.55$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 441.5397$$

$$fy_1 = 367.9498$$

$$su_1 = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.30$
 $su_1 = 0.4 * esu_{1,nominal} ((5.5), TBDY) = 0.032$
 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 $fs_1 = (fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 367.9498$
 with $Es_1 = (Es_{jacket} * A_{sl,ten,jacket} + Es_{core} * A_{sl,ten,core}) / A_{sl,ten} = 200000.00$
 $y_2 = 0.00140044$
 $sh_2 = 0.0044814$
 $ft_2 = 441.5397$
 $fy_2 = 367.9498$
 $su_2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.30$
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$
 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 $fs_2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 367.9498$
 with $Es_2 = (Es_{jacket} * A_{sl,com,jacket} + Es_{core} * A_{sl,com,core}) / A_{sl,com} = 200000.00$
 $y_v = 0.00140044$
 $sh_v = 0.0044814$
 $ft_v = 466.8167$
 $fy_v = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.30$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and 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 $fsv = (fs_{jacket} * A_{sl,mid,jacket} + fs_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 389.0139$
 with $Es_v = (Es_{jacket} * A_{sl,mid,jacket} + Es_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$
 $1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.04483877$
 $2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.04483877$
 $v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.01676222$
 and confined core properties:
 $b = 340.00$
 $d = 677.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.05508907$
 $2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.05508907$
 $v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.02059413$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.1553529$
 $Mu = MRc (4.14) = 3.5366E+008$
 $u = su (4.1) = 8.5738376E-006$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of μ_u

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

$$\mu_u = 8.5738376E-006$$

$$\mu_u = 3.5366E+008$$

with full section properties:

$$b = 400.00$$

$$d = 707.00$$

$$d' = 43.00$$

$$v = 0.00118049$$

$$N = 11016.808$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu_u: \mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, \alpha_{sc}) = 0.0052143$$

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

$$\text{From (5.4b), TB DY: } \mu_u = 0.0052143$$

$$\mu_{ue} (5.4c) = 0.00183676$$

$$\alpha_{se} ((5.4d), \text{TB DY}) = (\alpha_{se1} * A_{ext} + \alpha_{se2} * A_{int}) / A_{sec} = 0.12601038$$

$$\alpha_{se1} = 0.12601038$$

$$b_{o1} = 690.00$$

$$h_{o1} = 340.00$$

$$b_{i21} = 1.1834E+006$$

$$\alpha_{se2} = \text{Max}(\alpha_{se1}, \alpha_{se2}) = 0.12601038$$

$$b_{o2} = 542.00$$

$$h_{o2} = 192.00$$

$$b_{i22} = 661256.00$$

$$\mu_{sh,min} * F_{ywe} = \text{Min}(\mu_{sh,x} * F_{ywe}, \mu_{sh,y} * F_{ywe}) = 1.60339$$

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)

$$\mu_{sh,x} * F_{ywe} = \mu_{sh1} * F_{ywe1} + \mu_{sh2} * F_{ywe2} = 1.60339$$

$$\mu_{sh1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.0020944$$

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

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

$$h_1 = 400.00$$

$$\mu_{sh2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00026808$$

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

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

$$h_2 = 200.00$$

$$\mu_{sh,y} * F_{ywe} = \mu_{sh1} * F_{ywe1} + \mu_{sh2} * F_{ywe2} = 3.13667$$

$$\mu_{sh1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00392699$$

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

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

$$h_1 = 750.00$$

$$\mu_{sh2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00073723$$

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

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

$$h_2 = 550.00$$

$$A_{sec} = 300000.00$$

$$s_1 = 100.00$$

$$s_2 = 250.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 555.55$$

$$f_{ce} = 33.00$$

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

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

```

y1 = 0.00140044
sh1 = 0.0044814
ft1 = 441.5397
fy1 = 367.9498
su1 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 367.9498
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 441.5397
fy2 = 367.9498
su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/lb,min = 0.30
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 367.9498
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.30
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04483877
2 = Asl,com/(b*d)*(fs2/fc) = 0.04483877
v = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05508907
2 = Asl,com/(b*d)*(fs2/fc) = 0.05508907
v = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
---->
v < vs,y2 - LHS eq.(4.5) is satisfied
---->

```

$\mu_u(4.9) = 0.1553529$
 $\mu_u = M_{Rc}(4.14) = 3.5366E+008$
 $u = \mu_u(4.1) = 8.5738376E-006$

Calculation of ratio I_b/I_d

Inadequate Lap Length with $I_b/I_d = 0.30$

Calculation of Shear Strength $V_r = \min(V_{r1}, V_{r2}) = 923245.821$

Calculation of Shear Strength at edge 1, $V_{r1} = 923245.821$

$V_{r1} = V_{Col}((10.3), ASCE 41-17) = k_{nl} * V_{Col0}$

$V_{Col0} = 923245.821$

$k_{nl} = 1$ (zero step-static loading)

NOTE: In expression (10-3) ' $V_s = A_v * f_y * d / s$ ' is replaced by ' $V_s + f * V_f$ ' where V_f is the contribution of FRPs (11.3), ACI 440).

$= 1$ (normal-weight concrete)

Mean concrete strength: $f'_c = (f'_c_{jacket} * Area_{jacket} + f'_c_{core} * Area_{core}) / Area_{section} = 28.23333$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$M/Vd = 2.00$

$\mu_u = 6.8236829E-012$

$V_u = 3.9443045E-031$

$d = 0.8 * h = 600.00$

$N_u = 11016.808$

$A_g = 300000.00$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} = 602239.733$

where:

$V_{s1} = 523602.964$ is calculated for jacket, with:

$d = 600.00$

$A_v = 157079.633$

$f_y = 555.56$

$s = 100.00$

V_{s1} is multiplied by $Col1 = 1.00$

$s/d = 0.16666667$

$V_{s2} = 78636.768$ is calculated for core, with:

$d = 440.00$

$A_v = 100530.965$

$f_y = 444.44$

$s = 250.00$

V_{s2} is multiplied by $Col2 = 1.00$

$s/d = 0.56818182$

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

From (11-11), ACI 440: $V_s + V_f \leq 847147.582$

$b_w = 400.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 923245.821$

$V_{r2} = V_{Col}((10.3), ASCE 41-17) = k_{nl} * V_{Col0}$

$V_{Col0} = 923245.821$

$k_{nl} = 1$ (zero step-static loading)

NOTE: In expression (10-3) ' $V_s = A_v * f_y * d / s$ ' is replaced by ' $V_s + f * V_f$ ' where V_f is the contribution of FRPs (11.3), ACI 440).

$= 1$ (normal-weight concrete)

Mean concrete strength: $f'_c = (f'_c_{jacket} * Area_{jacket} + f'_c_{core} * Area_{core}) / Area_{section} = 28.23333$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$M/Vd = 2.00$

$\mu_u = 6.8236829E-012$

$V_u = 3.9443045E-031$

$d = 0.8 * h = 600.00$

$N_u = 11016.808$
 $A_g = 300000.00$
 From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} = 602239.733$
 where:
 $V_{s1} = 523602.964$ is calculated for jacket, with:
 $d = 600.00$
 $A_v = 157079.633$
 $f_y = 555.56$
 $s = 100.00$
 V_{s1} is multiplied by $Col1 = 1.00$
 $s/d = 0.16666667$
 $V_{s2} = 78636.768$ is calculated for core, with:
 $d = 440.00$
 $A_v = 100530.965$
 $f_y = 444.44$
 $s = 250.00$
 V_{s2} is multiplied by $Col2 = 1.00$
 $s/d = 0.56818182$
 $V_f ((11-3)-(11.4), ACI 440) = 0.00$
 From (11-11), ACI 440: $V_s + V_f \leq 847147.582$
 $b_w = 400.00$

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

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

Constant Properties

 Knowledge Factor, $\phi = 1.00$
 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, $f_c = f_{cm} = 33.00$
 New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.56$
 Concrete Elasticity, $E_c = 26999.444$
 Steel Elasticity, $E_s = 200000.00$
 Existing Column
 Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 20.00$
 Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 444.44$
 Concrete Elasticity, $E_c = 21019.039$
 Steel Elasticity, $E_s = 200000.00$
 External Height, $H = 400.00$
 External Width, $W = 750.00$
 Internal Height, $H = 200.00$
 Internal Width, $W = 550.00$
 Cover Thickness, $c = 25.00$
 Element Length, $L = 3000.00$
 Secondary Member
 Ribbed Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Inadequate Lap Length with $l_b/l_d = 0.30$
 No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 1.5146E+006$
 Shear Force, $V2 = 3386.997$
 Shear Force, $V3 = 3.7626771E-013$
 Axial Force, $F = -16097.112$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $As_t = 0.00$
 -Compression: $As_c = 2676.637$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{ten} = 1137.257$
 -Compression: $As_{com} = 1137.257$
 -Middle: $As_{mid} = 402.1239$
 Longitudinal External Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{ten,jacket} = 829.3805$
 -Compression: $As_{com,jacket} = 829.3805$
 -Middle: $As_{mid,jacket} = 402.1239$
 Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{ten,core} = 307.8761$
 -Compression: $As_{com,core} = 307.8761$
 -Middle: $As_{mid,core} = 0.00$
 Mean Diameter of Tension Reinforcement, $Db_L = 16.80$

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = u = 0.00034314$
 $u = y + p = 0.00034314$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.00034314$ ((4.29), Biskinis Phd))
 $M_y = 2.5076E+008$
 $L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 447.1746
 From table 10.5, ASCE 41_17: $E_{eff} = factor * E_c * I_g = 1.0893E+014$
 $factor = 0.30$
 $A_g = 300000.00$
 Mean concrete strength: $fc' = (fc'_{jacket} * Area_{jacket} + fc'_{core} * Area_{core}) / Area_{section} = 28.23333$
 $N = 16097.112$
 $E_c * I_g = E_{c,jacket} * I_{g,jacket} + E_{c,core} * I_{g,core} = 3.6310E+014$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

$y = \min(y_{ten}, y_{com})$
 $y_{ten} = 2.6761016E-006$
 with ((10.1), ASCE 41-17) $f_y = \min(f_y, 1.25 * f_y * (I_b / I_d)^{2/3}) = 296.8915$
 $d = 707.00$
 $y = 0.21540464$
 $A = 0.00965649$
 $B = 0.00521193$
 with $p_t = 0.00402142$
 $p_c = 0.00402142$
 $p_v = 0.00142194$
 $N = 16097.112$
 $b = 400.00$
 $\epsilon = 0.06082037$
 $y_{comp} = 1.4664753E-005$
 with $fc = 33.00$
 $E_c = 26999.444$
 $y = 0.21219612$
 $A = 0.00933541$
 $B = 0.00502021$
 with $E_s = 200000.00$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

- Calculation of p -

From table 10-8: $p = 0.00$

with:

- Columns controlled by inadequate development or splicing along the clear height because $l_b/l_d < 1$
shear control ratio $V_{yE}/V_{Col0E} = 0.25537128$

$d = d_{external} = 707.00$

$s = s_{external} = 0.00$

$t = s_1 + s_2 + 2 \cdot t_f/bw \cdot (f_{fe}/f_s) = 0.00466422$

jacket: $s_1 = A_{v1} \cdot h_1 / (s_1 \cdot A_g) = 0.00392699$

$A_{v1} = 157.0796$, is the total area of all stirrups parallel to loading (shear) direction

$h_1 = 750.00$

$s_1 = 100.00$

core: $s_2 = A_{v2} \cdot h_2 / (s_2 \cdot A_g) = 0.00073723$

$A_{v2} = 100.531$, is the total area of all stirrups parallel to loading (shear) direction

$h_2 = 550.00$

$s_2 = 250.00$

The term $2 \cdot t_f/bw \cdot (f_{fe}/f_s)$ is implemented to account for FRP contribution

where $f = 2 \cdot t_f/bw$ is FRP ratio (EC8 - 3, A.4.4.3(6)) and f_{fe}/f_s normalises f to steel strength

All these variables have already been given in Shear control ratio calculation.

For the normalisation f_s of jacket is used.

$NUD = 16097.112$

$A_g = 300000.00$

$f_{cE} = (f_{c_jacket} \cdot Area_jacket + f_{c_core} \cdot Area_core) / section_area = 28.23333$

$f_{yIE} = (f_{y_ext_Long_Reinf} \cdot Area_ext_Long_Reinf + f_{y_int_Long_Reinf} \cdot Area_int_Long_Reinf) / Area_Tot_Long_Rein = 529.9972$

$f_{yIE} = (f_{y_ext_Trans_Reinf} \cdot s_1 + f_{y_int_Trans_Reinf} \cdot s_2) / (s_1 + s_2) = 537.9964$

$\rho_l = Area_Tot_Long_Rein / (b \cdot d) = 0.00946477$

$b = 400.00$

$d = 707.00$

$f_{cE} = 28.23333$

End Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1

At local axis: 3

Integration Section: (b)

Calculation No. 9

column C1, Floor 1

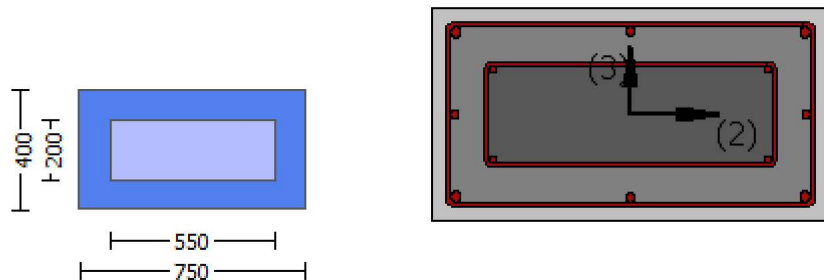
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity VR_d

Edge: Start

Local Axis: (2)



Start Of Calculation of Shear Capacity for element: column JC1 of floor 1

At local axis: 2

Integration Section: (a)

Section Type: rcjrs

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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, $f_c = f_{c_lower_bound} = 25.00$

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

Concrete Elasticity, $E_c = 26999.444$

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, $f_s = f_{s_lower_bound} = 400.00$

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of γ for displacement ductility demand, the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as Deformation-Controlled Action (Table C7-1, ASCE 41-17).

Jacket

New material: Concrete Strength, $f_c = f_{cm} = 33.00$

New material: Steel Strength, $f_s = f_{sm} = 555.56$

Existing Column

Existing material: Concrete Strength, $f_c = f_{cm} = 20.00$

Existing material: Steel Strength, $f_s = f_{sm} = 444.44$

#####

External Height, $H = 400.00$

External Width, $W = 750.00$

Internal Height, $H = 200.00$

Internal Width, $W = 550.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Ribbed Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Inadequate Lap Length with $l_o/l_{ou,min} = l_b/l_d = 0.30$
 No FRP Wrapping

Stepwise Properties

EDGE -A-
 Bending Moment, $M_a = -9.7390E+006$
 Shear Force, $V_a = -2823.172$
 EDGE -B-
 Bending Moment, $M_b = 1.2625E+006$
 Shear Force, $V_b = 2823.172$
 BOTH EDGES
 Axial Force, $F = -15251.406$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $As_t = 0.00$
 -Compression: $As_c = 2676.637$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten} = 1137.257$
 -Compression: $As_{l,com} = 1137.257$
 -Middle: $As_{l,mid} = 402.1239$
 Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 16.80$

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity $VR = *V_n = 683279.382$
 $V_n ((10.3), ASCE 41-17) = knl * V_{Col0} = 683279.382$
 $V_{Col} = 683279.382$
 $knl = 1.00$
 $displacement_ductility_demand = 0.02147243$

NOTE: In expression (10-3) ' $V_s = A_v * f_y * d / s$ ' is replaced by ' $V_{s+} = f * V_f$ '
 where V_f is the contribution of FRPs (11.3), ACI 440).

$= 1$ (normal-weight concrete)
 Mean concrete strength: $fc' = (fc'_{jacket} * Area_{jacket} + fc'_{core} * Area_{core}) / Area_{section} = 21.70$, but $fc'^{0.5} \leq 8.3$
 MPa (22.5.3.1, ACI 318-14)
 $M/Vd = 4.00$
 $M_u = 9.7390E+006$
 $V_u = 2823.172$
 $d = 0.8 * h = 600.00$
 $N_u = 15251.406$
 $A_g = 300000.00$
 From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} = 542012.697$
 where:
 $V_{s1} = 471238.898$ is calculated for jacket, with:
 $d = 600.00$
 $A_v = 157079.633$
 $f_y = 500.00$
 $s = 100.00$
 V_{s1} is multiplied by $Col1 = 1.00$
 $s/d = 0.16666667$
 $V_{s2} = 70773.799$ is calculated for core, with:
 $d = 440.00$
 $A_v = 100530.965$
 $f_y = 400.00$
 $s = 250.00$
 V_{s2} is multiplied by $Col2 = 1.00$
 $s/d = 0.56818182$
 $V_f ((11-3)-(11.4), ACI 440) = 0.00$
 From (11-11), ACI 440: $V_s + V_f \leq 742690.493$
 $bw = 400.00$

displacement_ductility_demand is calculated as ϕ_y

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

From analysis, chord rotation $\theta = 5.6781442E-005$

$y = (M_y * L_s / 3) / E_{eff} = 0.00264439$ ((4.29), Biskinis Phd))

$M_y = 2.5050E+008$

$L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 3449.669

From table 10.5, ASCE 41_17: $E_{eff} = factor * E_c * I_g = 1.0893E+014$

factor = 0.30

$A_g = 300000.00$

Mean concrete strength: $f_c' = (f_c'_{jacket} * Area_{jacket} + f_c'_{core} * Area_{core}) / Area_{section} = 28.23333$

$N = 15251.406$

$E_c * I_g = E_{c,jacket} * I_{g,jacket} + E_{c,core} * I_{g,core} = 3.6310E+014$

Calculation of Yielding Moment M_y

Calculation of ϕ_y and M_y according to Annex 7 -

$y = \min(\phi_{y,ten}, \phi_{y,com})$

$\phi_{y,ten} = 2.6754055E-006$

with ((10.1), ASCE 41-17) $f_y = \min(f_y, 1.25 * f_y * (l_b / l_d)^{2/3}) = 296.8915$

$d = 707.00$

$y = 0.21520049$

$A = 0.00964642$

$B = 0.00520186$

with $p_t = 0.00402142$

$p_c = 0.00402142$

$p_v = 0.00142194$

$N = 15251.406$

$b = 400.00$

$\rho = 0.06082037$

$\phi_{y,comp} = 1.4667378E-005$

with $f_c = 33.00$

$E_c = 26999.444$

$y = 0.21215815$

$A = 0.0093422$

$B = 0.00502021$

with $E_s = 200000.00$

Calculation of ratio l_b / l_d

Inadequate Lap Length with $l_b / l_d = 0.30$

End Of Calculation of Shear Capacity for element: column JC1 of floor 1

At local axis: 2

Integration Section: (a)

Calculation No. 10

column C1, Floor 1

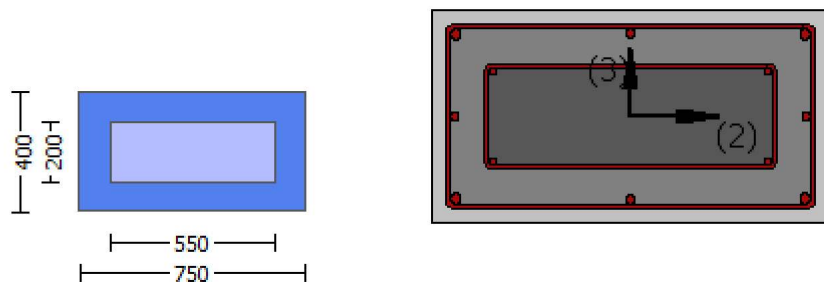
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (ϕ_u)

Edge: Start

Local Axis: (2)



Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjrs

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 33.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.56$

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 20.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 444.44$

Concrete Elasticity, $E_c = 21019.039$

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, $f_s = 1.25 \cdot f_{sm} = 694.45$

Existing Column

Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 555.55$

#####

External Height, $H = 400.00$

External Width, $W = 750.00$

Internal Height, $H = 200.00$

Internal Width, $W = 550.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length, $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with $l_o/l_{ou,min} = 0.30$
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, $V_a = -1.3927229E-031$
EDGE -B-
Shear Force, $V_b = 1.3927229E-031$
BOTH EDGES
Axial Force, $F = -11016.808$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $As_t = 0.00$
-Compression: $As_c = 2676.637$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $As_{t,ten} = 1137.257$
-Compression: $As_{l,com} = 1137.257$
-Middle: $As_{l,mid} = 402.1239$

Calculation of Shear Capacity ratio , $V_e/V_r = 0.19160863$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 115015.186$
with
 $M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 1.7252E+008$
 $Mu_{1+} = 1.7252E+008$, 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
 $Mu_{1-} = 1.7252E+008$, 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
 $M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 1.7252E+008$
 $Mu_{2+} = 1.7252E+008$, 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
 $Mu_{2-} = 1.7252E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination

Calculation of Mu_{1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 1.7214953E-005$
 $Mu = 1.7252E+008$

with full section properties:

$b = 750.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.00124684$
 $N = 11016.808$
 $f_c = 33.00$
 $\phi_c (5A.5, TBDY) = 0.002$
Final value of ϕ_u : $\phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.0052143$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $\phi_u = 0.0052143$
 $\phi_{we} (5.4c) = 0.00183676$
 $\phi_{ase} ((5.4d), TBDY) = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.12601038$
 $ase1 = 0.12601038$
 $bo_1 = 690.00$
 $ho_1 = 340.00$
 $bi2_1 = 1.1834E+006$
 $ase2 = \text{Max}(ase1, ase2) = 0.12601038$

$$bo_2 = 542.00$$

$$ho_2 = 192.00$$

$$bi2_2 = 661256.00$$

$$psh,min*Fywe = \text{Min}(psh,x*Fywe, psh,y*Fywe) = 1.60339$$

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)

$$psh_x*Fywe = psh1*Fywe1 + ps2*Fywe2 = 1.60339$$

$$ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.0020944$$

$$Ash1 = Astir_1*ns_1 = 157.0796$$

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

$$h1 = 400.00$$

$$ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00026808$$

$$Ash2 = Astir_2*ns_2 = 100.531$$

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

$$h2 = 200.00$$

$$psh_y*Fywe = psh1*Fywe1 + ps2*Fywe2 = 3.13667$$

$$ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00392699$$

$$Ash1 = Astir_1*ns_1 = 157.0796$$

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

$$h1 = 750.00$$

$$ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00073723$$

$$Ash2 = Astir_2*ns_2 = 100.531$$

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

$$h2 = 550.00$$

$$Asec = 300000.00$$

$$s1 = 100.00$$

$$s2 = 250.00$$

$$fywe1 = 694.45$$

$$fywe2 = 555.55$$

$$fce = 33.00$$

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

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

$$y1 = 0.00140044$$

$$sh1 = 0.0044814$$

$$ft1 = 441.5397$$

$$fy1 = 367.9498$$

$$su1 = 0.00512$$

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

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

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

$$\text{From table 5A.1, TBDY: } esu1_nominal = 0.08,$$

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

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

$$\text{with } fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 367.9498$$

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

$$y2 = 0.00140044$$

$$sh2 = 0.0044814$$

$$ft2 = 441.5397$$

$$fy2 = 367.9498$$

$$su2 = 0.00512$$

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

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

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

$$\text{From table 5A.1, TBDY: } esu2_nominal = 0.08,$$

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

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

$$\text{with } fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 367.9498$$

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

```

yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04735912
2 = Asl,com/(b*d)*(fs2/fc) = 0.04735912
v = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05619999
2 = Asl,com/(b*d)*(fs2/fc) = 0.05619999
v = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.16690234
Mu = MRc (4.14) = 1.7252E+008
u = su (4.1) = 1.7214953E-005

```

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

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

```

u = 1.7214953E-005
Mu = 1.7252E+008

```

with full section properties:

```

b = 750.00
d = 357.00
d' = 43.00
v = 0.00124684
N = 11016.808
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.0052143
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0052143
we (5.4c) = 0.00183676
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.12601038

```

```

ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
bi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
bi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.60339
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 = 1.60339
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirrups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirrups, ns_2 = 2.00
h2 = 200.00

```

```

-----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.13667
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirrups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirrups, ns_2 = 2.00
h2 = 550.00

```

```

-----
Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00
From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 441.5397
fy1 = 367.9498
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fsjacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 367.9498
with Es1 = (Esjacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 441.5397
fy2 = 367.9498
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,

```

For calculation of $es_{u2_nominal}$ and y_2 , sh_2 , ft_2 , fy_2 , it is considered characteristic value $fs_{y2} = fs_2/1.2$, 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 $fs_2 = (fs_{jacket} \cdot Asl_{com,jacket} + fs_{core} \cdot Asl_{com,core}) / Asl_{com} = 367.9498$

with $Es_2 = (Es_{jacket} \cdot Asl_{com,jacket} + Es_{core} \cdot Asl_{com,core}) / Asl_{com} = 200000.00$

$y_v = 0.00140044$

$sh_v = 0.0044814$

$ft_v = 466.8167$

$fy_v = 389.0139$

$suv = 0.00512$

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

$lo/lo_{u,min} = lb/ld = 0.30$

$suv = 0.4 \cdot es_{u_nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $es_{u_nominal} = 0.08$,

considering characteristic value $fs_{yv} = fs_v/1.2$, from table 5.1, TBDY

For calculation of $es_{u_nominal}$ and y_v , sh_v , ft_v , fy_v , it is considered characteristic value $fs_{yv} = fs_v/1.2$, 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 $fs_v = (fs_{jacket} \cdot Asl_{mid,jacket} + fs_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 389.0139$

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

$1 = Asl_{ten}/(b \cdot d) \cdot (fs_1/f_c) = 0.04735912$

$2 = Asl_{com}/(b \cdot d) \cdot (fs_2/f_c) = 0.04735912$

$v = Asl_{mid}/(b \cdot d) \cdot (fs_v/f_c) = 0.01770442$

and confined core properties:

$b = 690.00$

$d = 327.00$

$d' = 13.00$

$f_{cc} (5A.2, TBDY) = 33.00$

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

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

$1 = Asl_{ten}/(b \cdot d) \cdot (fs_1/f_c) = 0.05619999$

$2 = Asl_{com}/(b \cdot d) \cdot (fs_2/f_c) = 0.05619999$

$v = Asl_{mid}/(b \cdot d) \cdot (fs_v/f_c) = 0.02100943$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$su (4.9) = 0.16690234$

$Mu = MR_c (4.14) = 1.7252E+008$

$u = su (4.1) = 1.7214953E-005$

Calculation of ratio lb/ld

Inadequate Lap Length with $lb/ld = 0.30$

Calculation of Mu_{2+}

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

$u = 1.7214953E-005$

$Mu = 1.7252E+008$

with full section properties:

$b = 750.00$

$d = 357.00$

$d' = 43.00$

$v = 0.00124684$

$N = 11016.808$

$f_c = 33.00$

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

Final value of cu : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0052143$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $cu = 0.0052143$
we (5.4c) = 0.00183676
ase ((5.4d), TBDY) = $(ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.12601038$
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
bi2_1 = 1.1834E+006
ase2 = $\text{Max}(ase1, ase2) = 0.12601038$
bo_2 = 542.00
ho_2 = 192.00
bi2_2 = 661256.00
psh,min*Fywe = $\text{Min}(psh, x * F_{ywe}, psh, y * F_{ywe}) = 1.60339$
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 = $psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.60339$
ps1 (external) = $(A_{sh1} * h1 / s1) / A_{sec} = 0.0020944$
Ash1 = $A_{stir_1} * ns_1 = 157.0796$
No stirrups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = $(A_{sh2} * h2 / s2) / A_{sec} = 0.00026808$
Ash2 = $A_{stir_2} * ns_2 = 100.531$
No stirrups, ns_2 = 2.00
h2 = 200.00

psh_y*Fywe = $psh1 * F_{ywe1} + ps2 * F_{ywe2} = 3.13667$
ps1 (external) = $(A_{sh1} * h1 / s1) / A_{sec} = 0.00392699$
Ash1 = $A_{stir_1} * ns_1 = 157.0796$
No stirrups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = $(A_{sh2} * h2 / s2) / A_{sec} = 0.00073723$
Ash2 = $A_{stir_2} * ns_2 = 100.531$
No stirrups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.002
c = confinement factor = 1.00

y1 = 0.00140044
sh1 = 0.0044814
ft1 = 441.5397
fy1 = 367.9498
su1 = 0.00512

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

lo/lou,min = lb/ld = 0.30

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

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

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

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

with fs1 = $(f_{s,jacket} * A_{s,ten,jacket} + f_{s,core} * A_{s,ten,core}) / A_{s,ten} = 367.9498$

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

y2 = 0.00140044
sh2 = 0.0044814
ft2 = 441.5397
fy2 = 367.9498
su2 = 0.00512

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

and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.30$
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$
 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 $fs_2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 367.9498$
 with $Es_2 = (Es_{jacket} * A_{sl,com,jacket} + Es_{core} * A_{sl,com,core}) / A_{sl,com} = 200000.00$
 $y_v = 0.00140044$
 $sh_v = 0.0044814$
 $ft_v = 466.8167$
 $fy_v = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.30$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsv = fs_v/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fsv = fs_v/1.2$, 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 $fs_v = (fs_{jacket} * A_{sl,mid,jacket} + fs_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 389.0139$
 with $Es_v = (Es_{jacket} * A_{sl,mid,jacket} + Es_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$
 $1 = A_{sl,ten} / (b * d) * (fs_1 / f_c) = 0.04735912$
 $2 = A_{sl,com} / (b * d) * (fs_2 / f_c) = 0.04735912$
 $v = A_{sl,mid} / (b * d) * (fs_v / f_c) = 0.01770442$
 and confined core properties:
 $b = 690.00$
 $d = 327.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten} / (b * d) * (fs_1 / f_c) = 0.05619999$
 $2 = A_{sl,com} / (b * d) * (fs_2 / f_c) = 0.05619999$
 $v = A_{sl,mid} / (b * d) * (fs_v / f_c) = 0.02100943$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y_2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.16690234$
 $Mu = MR_c (4.14) = 1.7252E+008$
 $u = su (4.1) = 1.7214953E-005$

 Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Mu_2 -

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

$$u = 1.7214953E-005$$

$$Mu = 1.7252E+008$$

 with full section properties:

$$b = 750.00$$

$$d = 357.00$$

$d' = 43.00$
 $v = 0.00124684$
 $N = 11016.808$
 $fc = 33.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = shear_factor * Max(cu, cc) = 0.0052143$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.0052143$
 $we (5.4c) = 0.00183676$
 $ase ((5.4d), TBDY) = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.12601038$
 $ase1 = 0.12601038$
 $bo_1 = 690.00$
 $ho_1 = 340.00$
 $bi2_1 = 1.1834E+006$
 $ase2 = Max(ase1, ase2) = 0.12601038$
 $bo_2 = 542.00$
 $ho_2 = 192.00$
 $bi2_2 = 661256.00$
 $psh, min * F_{ywe} = Min(psh, x * F_{ywe}, psh, y * F_{ywe}) = 1.60339$
 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)

$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.60339$
 $ps1 (external) = (Ash1 * h1 / s1) / A_{sec} = 0.0020944$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 (internal) = (Ash2 * h2 / s2) / A_{sec} = 0.00026808$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

$psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 3.13667$
 $ps1 (external) = (Ash1 * h1 / s1) / A_{sec} = 0.00392699$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 750.00$
 $ps2 (internal) = (Ash2 * h2 / s2) / A_{sec} = 0.00073723$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 550.00$

$A_{sec} = 300000.00$
 $s1 = 100.00$
 $s2 = 250.00$
 $fywe1 = 694.45$
 $fywe2 = 555.55$
 $f_{ce} = 33.00$

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

$y1 = 0.00140044$
 $sh1 = 0.0044814$
 $ft1 = 441.5397$
 $fy1 = 367.9498$
 $su1 = 0.00512$

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

$lo/lo_{u,min} = lb/ld = 0.30$

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

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

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

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

with $fs1 = (fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 367.9498$

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

$y2 = 0.00140044$

```

sh2 = 0.0044814
ft2 = 441.5397
fy2 = 367.9498
su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/lb,min = 0.30
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 367.9498
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/ld = 0.30
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04735912
2 = Asl,com/(b*d)*(fs2/fc) = 0.04735912
v = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05619999
2 = Asl,com/(b*d)*(fs2/fc) = 0.05619999
v = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.16690234
Mu = MRc (4.14) = 1.7252E+008
u = su (4.1) = 1.7214953E-005

```

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength $V_r = \min(V_{r1}, V_{r2}) = 600261.003$

Calculation of Shear Strength at edge 1, $V_{r1} = 600261.003$

$V_{r1} = V_{Col} ((10.3), ASCE 41-17) = k_n l * V_{Col0}$

$V_{Col0} = 600261.003$

knl = 1 (zero step-static loading)

NOTE: In expression (10-3) ' $V_s = A_v \cdot f_y \cdot d / s$ ' is replaced by ' $V_s + f \cdot V_f$ ' where V_f is the contribution of FRPs (11.3), ACI 440).

= 1 (normal-weight concrete)

Mean concrete strength: $f'_c = (f'_c \cdot \text{jacket} \cdot \text{Area}_{\text{jacket}} + f'_c \cdot \text{core} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 28.23333$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$M/Vd = 2.00$

$\mu_u = 1.0002017E-011$

$\nu_u = 1.3927229E-031$

$d = 0.8 \cdot h = 320.00$

$N_u = 11016.808$

$A_g = 300000.00$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} = 279254.914$

where:

$V_{s1} = 279254.914$ is calculated for jacket, with:

$d = 320.00$

$A_v = 157079.633$

$f_y = 555.56$

$s = 100.00$

V_{s1} is multiplied by $\text{Col1} = 1.00$

$s/d = 0.3125$

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

$d = 160.00$

$A_v = 100530.965$

$f_y = 444.44$

$s = 250.00$

V_{s2} is multiplied by $\text{Col2} = 0.00$

$s/d = 1.5625$

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

From (11-11), ACI 440: $V_s + V_f \leq 847147.582$

$b_w = 750.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 600261.003$

$V_{r2} = V_{\text{Col}} \text{ ((10.3), ASCE 41-17)} = \text{knl} \cdot V_{\text{Col0}}$

$V_{\text{Col0}} = 600261.003$

knl = 1 (zero step-static loading)

NOTE: In expression (10-3) ' $V_s = A_v \cdot f_y \cdot d / s$ ' is replaced by ' $V_s + f \cdot V_f$ ' where V_f is the contribution of FRPs (11.3), ACI 440).

= 1 (normal-weight concrete)

Mean concrete strength: $f'_c = (f'_c \cdot \text{jacket} \cdot \text{Area}_{\text{jacket}} + f'_c \cdot \text{core} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 28.23333$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$M/Vd = 2.00$

$\mu_u = 1.0002017E-011$

$\nu_u = 1.3927229E-031$

$d = 0.8 \cdot h = 320.00$

$N_u = 11016.808$

$A_g = 300000.00$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} = 279254.914$

where:

$V_{s1} = 279254.914$ is calculated for jacket, with:

$d = 320.00$

$A_v = 157079.633$

$f_y = 555.56$

$s = 100.00$

V_{s1} is multiplied by $\text{Col1} = 1.00$

$s/d = 0.3125$

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

$d = 160.00$

$A_v = 100530.965$

$f_y = 444.44$

$s = 250.00$

V_{s2} is multiplied by $\text{Col2} = 0.00$

```

s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 847147.582
bw = 750.00
-----

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

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

Constant Properties
-----
Knowledge Factor,   = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fcm = 20.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 444.44
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
#####
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
Existing material: Steel Strength, fs = 1.25*fsm = 555.55
#####
External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lo,min = 0.30
No FRP Wrapping
-----

Stepwise Properties
-----
At local axis: 2
EDGE -A-
Shear Force, Va = -3.9443045E-031
EDGE -B-
Shear Force, Vb = 3.9443045E-031
BOTH EDGES
Axial Force, F = -11016.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00

```

-Compression: $Asl,c = 2676.637$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $Asl,t = 1137.257$
 -Compression: $Asl,c = 1137.257$
 -Middle: $Asl,m = 402.1239$

Calculation of Shear Capacity ratio , $V_e/V_r = 0.25537128$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 235770.47$
 with

$M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 3.5366E+008$

$Mu_{1+} = 3.5366E+008$, 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

$Mu_{1-} = 3.5366E+008$, 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

$M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 3.5366E+008$

$Mu_{2+} = 3.5366E+008$, 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

$Mu_{2-} = 3.5366E+008$, 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

Calculation of Mu_{1+}

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

$\phi_u = 8.5738376E-006$

$M_u = 3.5366E+008$

with full section properties:

$b = 400.00$

$d = 707.00$

$d' = 43.00$

$v = 0.00118049$

$N = 11016.808$

$f_c = 33.00$

ϕ_c (5A.5, TBDY) = 0.002

Final value of ϕ_u : $\phi_u^* = \text{shear_factor} * \text{Max}(\phi_c, \phi_u) = 0.0052143$

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

From (5.4b), TBDY: $\phi_u = 0.0052143$

ϕ_{ue} (5.4c) = 0.00183676

ϕ_{ase} ((5.4d), TBDY) = $(\phi_{ase1} * A_{ext} + \phi_{ase2} * A_{int}) / A_{sec} = 0.12601038$

$\phi_{ase1} = 0.12601038$

$b_{o_1} = 690.00$

$h_{o_1} = 340.00$

$b_{i2_1} = 1.1834E+006$

$\phi_{ase2} = \text{Max}(\phi_{ase1}, \phi_{ase2}) = 0.12601038$

$b_{o_2} = 542.00$

$h_{o_2} = 192.00$

$b_{i2_2} = 661256.00$

$\phi_{psh,min} * F_{ywe} = \text{Min}(\phi_{psh,x} * F_{ywe}, \phi_{psh,y} * F_{ywe}) = 1.60339$

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)

$\phi_{psh,x} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{psh2} * F_{ywe2} = 1.60339$

ϕ_{ps1} (external) = $(\phi_{ash1} * h_1 / s_1) / A_{sec} = 0.0020944$

$\phi_{ash1} = \phi_{astir_1} * n_{s_1} = 157.0796$

No stirrups, $n_{s_1} = 2.00$

$h_1 = 400.00$

ϕ_{ps2} (internal) = $(\phi_{ash2} * h_2 / s_2) / A_{sec} = 0.00026808$

$\phi_{ash2} = \phi_{astir_2} * n_{s_2} = 100.531$

No stirrups, $n_{s_2} = 2.00$

$h_2 = 200.00$

```

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.13667
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

```

```

Asec = 300000.00

```

```

s1 = 100.00

```

```

s2 = 250.00

```

```

fywe1 = 694.45

```

```

fywe2 = 555.55

```

```

fce = 33.00

```

```

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

```

```

c = confinement factor = 1.00

```

```

y1 = 0.00140044

```

```

sh1 = 0.0044814

```

```

ft1 = 441.5397

```

```

fy1 = 367.9498

```

```

su1 = 0.00512

```

```

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

```

```

lo/lou,min = lb/ld = 0.30

```

```

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

```

```

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

```

```

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

```

```

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

```

```

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 367.9498

```

```

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

```

```

y2 = 0.00140044

```

```

sh2 = 0.0044814

```

```

ft2 = 441.5397

```

```

fy2 = 367.9498

```

```

su2 = 0.00512

```

```

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

```

```

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

```

```

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

```

```

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

```

```

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

```

```

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

```

```

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 367.9498

```

```

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

```

```

yv = 0.00140044

```

```

shv = 0.0044814

```

```

ftv = 466.8167

```

```

fyv = 389.0139

```

```

suv = 0.00512

```

```

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

```

```

lo/lou,min = lb/ld = 0.30

```

```

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

```

```

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

```

```

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

```

```

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

```

```

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

```

```

with Esv = (Esjacket*Aslmid,jacket + Esmid*Aslmid,core)/Aslmid = 200000.00
1 = Aslten/(b*d)*(fs1/fc) = 0.04483877
2 = Aslcom/(b*d)*(fs2/fc) = 0.04483877
v = Aslmid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Aslten/(b*d)*(fs1/fc) = 0.05508907
2 = Aslcom/(b*d)*(fs2/fc) = 0.05508907
v = Aslmid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.1553529
Mu = MRc (4.14) = 3.5366E+008
u = su (4.1) = 8.5738376E-006
-----

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

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 8.5738376E-006
Mu = 3.5366E+008
-----

with full section properties:
b = 400.00
d = 707.00
d' = 43.00
v = 0.00118049
N = 11016.808
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.0052143
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0052143
we (5.4c) = 0.00183676
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
bi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
bi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.60339
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 = 1.60339
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirrups, ns_1 = 2.00

```


$h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00026808$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 No stirups, $ns_2 = 2.00$
 $h2 = 200.00$

$psh_y \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 3.13667$
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00392699$
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$
 No stirups, $ns_1 = 2.00$
 $h1 = 750.00$
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00073723$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 No stirups, $ns_2 = 2.00$
 $h2 = 550.00$

$Asec = 300000.00$
 $s1 = 100.00$
 $s2 = 250.00$
 $fywe1 = 694.45$
 $fywe2 = 555.55$
 $fce = 33.00$

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

$y1 = 0.00140044$
 $sh1 = 0.0044814$
 $ft1 = 441.5397$
 $fy1 = 367.9498$
 $su1 = 0.00512$

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

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

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

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 $fs1 = (fs_jacket \cdot Asl, ten, jacket + fs_core \cdot Asl, ten, core) / Asl, ten = 367.9498$

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

$y2 = 0.00140044$
 $sh2 = 0.0044814$
 $ft2 = 441.5397$
 $fy2 = 367.9498$
 $su2 = 0.00512$

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

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

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

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 $fs2 = (fs_jacket \cdot Asl, com, jacket + fs_core \cdot Asl, com, core) / Asl, com = 367.9498$

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

$yv = 0.00140044$
 $shv = 0.0044814$
 $ftv = 466.8167$
 $fyv = 389.0139$
 $suv = 0.00512$

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

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

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

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

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 , fy_v , 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 $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 389.0139$

with $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.04483877$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.04483877$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.01676222$

and confined core properties:

$b = 340.00$

$d = 677.00$

$d' = 13.00$

f_{cc} (5A.2, TBDY) = 33.00

cc (5A.5, TBDY) = 0.002

c = confinement factor = 1.00

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.05508907$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.05508907$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.02059413$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

su (4.9) = 0.1553529

$Mu = MR_c$ (4.14) = 3.5366E+008

$u = su$ (4.1) = 8.5738376E-006

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Mu_{2+}

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

$u = 8.5738376E-006$

$Mu = 3.5366E+008$

with full section properties:

$b = 400.00$

$d = 707.00$

$d' = 43.00$

$v = 0.00118049$

$N = 11016.808$

$f_c = 33.00$

cc (5A.5, TBDY) = 0.002

Final value of cu : $cu^* = \text{shear_factor} \cdot \text{Max}(cu, cc) = 0.0052143$

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

From (5.4b), TBDY: $cu = 0.0052143$

w_e (5.4c) = 0.00183676

ase ((5.4d), TBDY) = $(ase1 \cdot A_{ext} + ase2 \cdot A_{int}) / A_{sec} = 0.12601038$

$ase1 = 0.12601038$

$bo_1 = 690.00$

$ho_1 = 340.00$

$bi2_1 = 1.1834E+006$

$ase2 = \text{Max}(ase1, ase2) = 0.12601038$

$bo_2 = 542.00$

$ho_2 = 192.00$

$bi2_2 = 661256.00$

$psh, \min \cdot F_{ywe} = \text{Min}(psh, x \cdot F_{ywe}, psh, y \cdot F_{ywe}) = 1.60339$

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)

$psh_x \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 1.60339$
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.0020944$
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$
 No stirups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00026808$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 No stirups, $ns_2 = 2.00$
 $h2 = 200.00$

$psh_y \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 3.13667$
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00392699$
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$
 No stirups, $ns_1 = 2.00$
 $h1 = 750.00$
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00073723$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 No stirups, $ns_2 = 2.00$
 $h2 = 550.00$

$Asec = 300000.00$
 $s1 = 100.00$
 $s2 = 250.00$
 $fywe1 = 694.45$
 $fywe2 = 555.55$
 $fce = 33.00$
 From ((5.A5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$
 $y1 = 0.00140044$
 $sh1 = 0.0044814$
 $ft1 = 441.5397$
 $fy1 = 367.9498$
 $su1 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou, min = lb/ld = 0.30$
 $su1 = 0.4 \cdot esu1_nominal \text{ ((5.5), TBDY)} = 0.032$
 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 $fs1 = (fs_jacket \cdot Asl, ten, jacket + fs_core \cdot Asl, ten, core) / Asl, ten = 367.9498$
 with $Es1 = (Es_jacket \cdot Asl, ten, jacket + Es_core \cdot Asl, ten, core) / Asl, ten = 200000.00$
 $y2 = 0.00140044$
 $sh2 = 0.0044814$
 $ft2 = 441.5397$
 $fy2 = 367.9498$
 $su2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou, min = lb/lb, min = 0.30$
 $su2 = 0.4 \cdot esu2_nominal \text{ ((5.5), TBDY)} = 0.032$
 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 $fs2 = (fs_jacket \cdot Asl, com, jacket + fs_core \cdot Asl, com, core) / Asl, com = 367.9498$
 with $Es2 = (Es_jacket \cdot Asl, com, jacket + Es_core \cdot Asl, com, core) / Asl, com = 200000.00$
 $yv = 0.00140044$
 $shv = 0.0044814$
 $ftv = 466.8167$
 $fyv = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.30$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and yv, shv, ftv, fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs_{jacket} * Asl_{mid,jacket} + fs_{mid} * Asl_{mid,core}) / Asl_{mid} = 389.0139$
 with $Esv = (Es_{jacket} * Asl_{mid,jacket} + Es_{mid} * Asl_{mid,core}) / Asl_{mid} = 200000.00$
 $1 = Asl_{ten} / (b * d) * (fs1 / fc) = 0.04483877$
 $2 = Asl_{com} / (b * d) * (fs2 / fc) = 0.04483877$
 $v = Asl_{mid} / (b * d) * (fsv / fc) = 0.01676222$
 and confined core properties:
 $b = 340.00$
 $d = 677.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl_{ten} / (b * d) * (fs1 / fc) = 0.05508907$
 $2 = Asl_{com} / (b * d) * (fs2 / fc) = 0.05508907$
 $v = Asl_{mid} / (b * d) * (fsv / fc) = 0.02059413$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.1553529$
 $Mu = MRc (4.14) = 3.5366E+008$
 $u = su (4.1) = 8.5738376E-006$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of $Mu2$ -

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

$u = 8.5738376E-006$
 $Mu = 3.5366E+008$

with full section properties:

$b = 400.00$
 $d = 707.00$
 $d' = 43.00$
 $v = 0.00118049$
 $N = 11016.808$
 $fc = 33.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0052143$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.0052143$
 $we (5.4c) = 0.00183676$
 $ase ((5.4d), TBDY) = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.12601038$
 $ase1 = 0.12601038$
 $bo_1 = 690.00$
 $ho_1 = 340.00$
 $bi2_1 = 1.1834E+006$
 $ase2 = \text{Max}(ase1, ase2) = 0.12601038$
 $bo_2 = 542.00$

$ho_2 = 192.00$
 $bi2_2 = 661256.00$
 $psh,min*Fywe = \text{Min}(psh,x*Fywe, psh,y*Fywe) = 1.60339$
 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)

$psh_x*Fywe = psh1*Fywe1 + ps2*Fywe2 = 1.60339$
 $ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.0020944$
 $Ash1 = Astir_1*ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00026808$
 $Ash2 = Astir_2*ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

$psh_y*Fywe = psh1*Fywe1 + ps2*Fywe2 = 3.13667$
 $ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00392699$
 $Ash1 = Astir_1*ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 750.00$
 $ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00073723$
 $Ash2 = Astir_2*ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 550.00$

$Asec = 300000.00$
 $s1 = 100.00$
 $s2 = 250.00$
 $fywe1 = 694.45$
 $fywe2 = 555.55$
 $fce = 33.00$

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

$y1 = 0.00140044$
 $sh1 = 0.0044814$
 $ft1 = 441.5397$
 $fy1 = 367.9498$
 $su1 = 0.00512$

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

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

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

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 $fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 367.9498$

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

$y2 = 0.00140044$
 $sh2 = 0.0044814$
 $ft2 = 441.5397$
 $fy2 = 367.9498$
 $su2 = 0.00512$

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

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

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

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 $fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 367.9498$

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

$yv = 0.00140044$

$shv = 0.0044814$
 $ftv = 466.8167$
 $fyv = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/ld = 0.30$
 $suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv , shv,ftv,fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1,ft1,fy1$, are also multiplied by $Min(1,1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139$
 with $Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.04483877$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.04483877$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.01676222$

and confined core properties:

$b = 340.00$
 $d = 677.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.05508907$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.05508907$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.02059413$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$su (4.9) = 0.1553529$
 $Mu = MRc (4.14) = 3.5366E+008$
 $u = su (4.1) = 8.5738376E-006$

Calculation of ratio lb/ld

Inadequate Lap Length with $lb/ld = 0.30$

Calculation of Shear Strength $Vr = Min(Vr1,Vr2) = 923245.821$

Calculation of Shear Strength at edge 1, $Vr1 = 923245.821$

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

$VColO = 923245.821$

$knl = 1$ (zero step-static loading)

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

$= 1$ (normal-weight concrete)

Mean concrete strength: $fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 28.23333$, but $fc'^{0.5} <= 8.3$ MPa (22.5.3.1, ACI 318-14)

$M/Vd = 2.00$

$Mu = 6.8236829E-012$

$Vu = 3.9443045E-031$

$d = 0.8*h = 600.00$

$Nu = 11016.808$

$Ag = 300000.00$

From (11.5.4.8), ACI 318-14: $Vs = Vs1 + Vs2 = 602239.733$

where:

Vs1 = 523602.964 is calculated for jacket, with:

$$d = 600.00$$

$$A_v = 157079.633$$

$$f_y = 555.56$$

$$s = 100.00$$

Vs1 is multiplied by Col1 = 1.00

$$s/d = 0.16666667$$

Vs2 = 78636.768 is calculated for core, with:

$$d = 440.00$$

$$A_v = 100530.965$$

$$f_y = 444.44$$

$$s = 250.00$$

Vs2 is multiplied by Col2 = 1.00

$$s/d = 0.56818182$$

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

From (11-11), ACI 440: Vs + Vf <= 847147.582

$$bw = 400.00$$

Calculation of Shear Strength at edge 2, Vr2 = 923245.821

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

$$VCol0 = 923245.821$$

knl = 1 (zero step-static loading)

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

= 1 (normal-weight concrete)

Mean concrete strength: $f_c' = (f_c'_{jacket} * Area_{jacket} + f_c'_{core} * Area_{core}) / Area_{section} = 28.23333$, but $f_c'^{0.5} <= 8.3$ MPa (22.5.3.1, ACI 318-14)

$$M/Vd = 2.00$$

$$Mu = 6.8236829E-012$$

$$Vu = 3.9443045E-031$$

$$d = 0.8 * h = 600.00$$

$$Nu = 11016.808$$

$$Ag = 300000.00$$

From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 602239.733

where:

Vs1 = 523602.964 is calculated for jacket, with:

$$d = 600.00$$

$$A_v = 157079.633$$

$$f_y = 555.56$$

$$s = 100.00$$

Vs1 is multiplied by Col1 = 1.00

$$s/d = 0.16666667$$

Vs2 = 78636.768 is calculated for core, with:

$$d = 440.00$$

$$A_v = 100530.965$$

$$f_y = 444.44$$

$$s = 250.00$$

Vs2 is multiplied by Col2 = 1.00

$$s/d = 0.56818182$$

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

From (11-11), ACI 440: Vs + Vf <= 847147.582

$$bw = 400.00$$

End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1

At local axis: 2

Integration Section: (a)

Section Type: rcjrs

Constant Properties

Knowledge Factor, $\phi = 1.00$

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, $f_c = f_{cm} = 33.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.56$

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 20.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 444.44$

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

External Height, $H = 400.00$

External Width, $W = 750.00$

Internal Height, $H = 200.00$

Internal Width, $W = 550.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_b/l_d = 0.30$

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 9.2596107E-010$

Shear Force, $V_2 = -2823.172$

Shear Force, $V_3 = -3.1363135E-013$

Axial Force, $F = -15251.406$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 0.00$

-Compression: $As_c = 2676.637$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten} = 1137.257$

-Compression: $As_{l,com} = 1137.257$

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

Longitudinal External Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten,jacket} = 829.3805$

-Compression: $As_{l,com,jacket} = 829.3805$

-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: $As_{l,mid,core} = 0.00$

Mean Diameter of Tension Reinforcement, $Db_L = 16.80$

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = \phi \cdot u = 0.01790598$

$u = y + p = 0.01790598$

- Calculation of y -

$y = (M_y \cdot L_s / 3) / E_{eff} = 0.00198111 \text{ ((4.29), Biskinis Phd)}$

$M_y = 1.2577E+008$

$L_s = M/V \text{ (with } L_s > 0.1 \cdot L \text{ and } L_s < 2 \cdot L) = 1500.00$

From table 10.5, ASCE 41_17: $E_{eff} = factor * E_c * I_g = 3.1741E+013$

factor = 0.30

$A_g = 300000.00$

Mean concrete strength: $f_c' = (f_c'_{jacket} * Area_{jacket} + f_c'_{core} * Area_{core}) / Area_{section} = 28.23333$

$N = 15251.406$

$E_c * I_g = E_{c,jacket} * I_{g,jacket} + E_{c,core} * I_{g,core} = 1.0580E+014$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$

$y_{ten} = 5.3794571E-006$

with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25 * f_y * (I_b / I_d)^{2/3}) = 296.8915$

$d = 357.00$

$y = 0.22703277$

$A = 0.01018864$

$B = 0.00579229$

with $pt = 0.00424746$

$pc = 0.00424746$

$pv = 0.00150186$

$N = 15251.406$

$b = 750.00$

$" = 0.12044818$

$y_{comp} = 2.7501333E-005$

with $f_c = 33.00$

$E_c = 26999.444$

$y = 0.22408338$

$A = 0.00986732$

$B = 0.00560044$

with $E_s = 200000.00$

Calculation of ratio I_b / I_d

Inadequate Lap Length with $I_b / I_d = 0.30$

- Calculation of p -

From table 10-8: $p = 0.01592487$

with:

- Columns controlled by inadequate development or splicing along the clear height because $I_b / I_d < 1$

shear control ratio $V_y E / V_{col} E = 0.19160863$

$d = d_{external} = 357.00$

$s = s_{external} = 0.00$

$t = s_1 + s_2 + 2 * t_f / b_w * (f_{fe} / f_s) = 0.00236248$

jacket: $s_1 = A_{v1} * h_1 / (s_1 * A_g) = 0.0020944$

$A_{v1} = 157.0796$, is the total area of all stirrups parallel to loading (shear) direction

$h_1 = 400.00$

$s_1 = 100.00$

core: $s_2 = A_{v2} * h_2 / (s_2 * A_g) = 0.00026808$

$A_{v2} = 100.531$, is the total area of all stirrups parallel to loading (shear) direction

$h_2 = 200.00$

$s_2 = 250.00$

The term $2 * t_f / b_w * (f_{fe} / f_s)$ is implemented to account for FRP contribution

where $f = 2 * t_f / b_w$ is FRP ratio (EC8 - 3, A.4.4.3(6)) and f_{fe} / f_s normalises f to steel strength

All these variables have already been given in Shear control ratio calculation.

For the normalisation f_s of jacket is used.

$N_{UD} = 15251.406$

$A_g = 300000.00$

$f_{cE} = (f_{c,jacket} * Area_{jacket} + f_{c,core} * Area_{core}) / section_area = 28.23333$

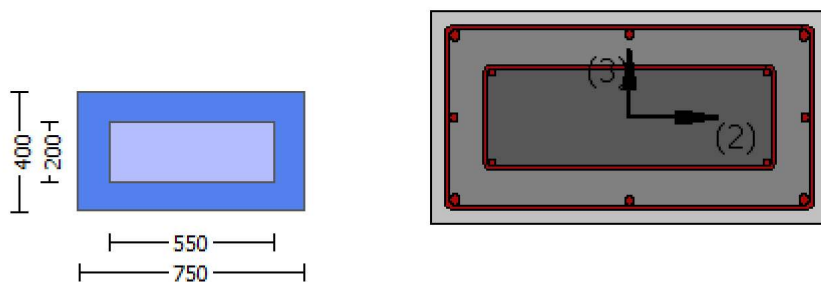
$f_{yE} = (f_{y,ext_Long_Reinf} * Area_{ext_Long_Reinf} + f_{y,int_Long_Reinf} * Area_{int_Long_Reinf}) / Area_{Tot_Long_Rein} = 529.9972$

$f_{tE} = (f_{y_ext_Trans_Reinf} \cdot s_1 + f_{y_int_Trans_Reinf} \cdot s_2) / (s_1 + s_2) = 542.9506$
 $p_l = Area_Tot_Long_Rein / (b \cdot d) = 0.00999678$
 $b = 750.00$
 $d = 357.00$
 $f_{cE} = 28.23333$

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

Calculation No. 11

column C1, Floor 1
 Limit State: 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: column JC1 of floor 1
 At local axis: 3
 Integration Section: (a)
 Section Type: rcjrs

Constant Properties

 Knowledge Factor, $\gamma = 1.00$
 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, $f_c = f_{c_lower_bound} = 25.00$
 New material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$
 Concrete Elasticity, $E_c = 26999.444$
 Steel Elasticity, $E_s = 200000.00$

```

Existing Column
Existing material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 16.00
Existing material of Secondary Member: Steel Strength, fs = fs_lower_bound = 400.00
Concrete Elasticity, Ec = 21019.039
Steel Elasticity, Es = 200000.00
#####
Note: Especially for the calculation of  $\mu_y$  for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
Existing material: Concrete Strength, fc = fcm = 20.00
Existing material: Steel Strength, fs = fsm = 444.44
#####
External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with  $l_o/l_{ou,min} = l_b/l_d = 0.30$ 
No FRP Wrapping
-----

Stepwise Properties
-----
EDGE -A-
Bending Moment, Ma = 9.2596107E-010
Shear Force, Va = -3.1363135E-013
EDGE -B-
Bending Moment, Mb = 1.6814758E-011
Shear Force, Vb = 3.1363135E-013
BOTH EDGES
Axial Force, F = -15251.406
Longitudinal Reinforcement Area Distribution (in 2 divisions)
  -Tension: Aslt = 0.00
  -Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
  -Tension: Asl,ten = 1137.257
  -Compression: Asl,com = 1137.257
  -Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL,ten = 16.80
-----
-----

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR =  $\phi V_n = 533860.781$ 
Vn ((10.3), ASCE 41-17) = knl*VColO = 533860.781
VCol = 533860.781
knl = 1.00
displacement_ductility_demand = 0.00
-----
NOTE: In expression (10-3) ' $V_s = A_v \cdot f_y \cdot d / s$ ' is replaced by ' $V_{s+} = f^* V_f$ '
where  $V_f$  is the contribution of FRPs (11.3), ACI 440).
-----
= 1 (normal-weight concrete)
Mean concrete strength:  $f_c' = (f_c'_{jacket} \cdot Area_{jacket} + f_c'_{core} \cdot Area_{core}) / Area_{section} = 21.70$ , but  $f_c'^{0.5} \leq 8.3$ 
MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 9.2596107E-010

```

$V_u = 3.1363135E-013$
 $d = 0.8 \cdot h = 320.00$
 $N_u = 15251.406$
 $A_g = 300000.00$
 From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} = 251327.412$
 where:
 $V_{s1} = 251327.412$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 500.00$
 $s = 100.00$
 V_{s1} is multiplied by $Col1 = 1.00$
 $s/d = 0.3125$
 $V_{s2} = 0.00$ is calculated for core, with:
 $d = 160.00$
 $A_v = 100530.965$
 $f_y = 400.00$
 $s = 250.00$
 V_{s2} is multiplied by $Col2 = 0.00$
 $s/d = 1.5625$
 $V_f ((11-3)-(11.4), ACI 440) = 0.00$
 From (11-11), ACI 440: $V_s + V_f \leq 742690.493$
 $bw = 750.00$

displacement_ductility_demand is calculated as ϕ / y

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

From analysis, chord rotation $\phi = 1.5278639E-020$
 $y = (M_y \cdot L_s / 3) / E_{eff} = 0.00198111$ ((4.29), Biskinis Phd))
 $M_y = 1.2577E+008$
 $L_s = M/V$ (with $L_s > 0.1 \cdot L$ and $L_s < 2 \cdot L$) = 1500.00
 From table 10.5, ASCE 41_17: $E_{eff} = factor \cdot E_c \cdot I_g = 3.1741E+013$
 $factor = 0.30$
 $A_g = 300000.00$
 Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot Area_{jacket} + f'_{c_core} \cdot Area_{core}) / Area_{section} = 28.23333$
 $N = 15251.406$
 $E_c \cdot I_g = E_{c_jacket} \cdot I_{g_jacket} + E_{c_core} \cdot I_{g_core} = 1.0580E+014$

Calculation of Yielding Moment M_y

Calculation of ϕ and M_y according to Annex 7 -

$y = \min(y_{ten}, y_{com})$
 $y_{ten} = 5.3794571E-006$
 with ((10.1), ASCE 41-17) $f_y = \min(f_y, 1.25 \cdot f_y \cdot (I_b / I_d)^{2/3}) = 296.8915$
 $d = 357.00$
 $y = 0.22703277$
 $A = 0.01018864$
 $B = 0.00579229$
 with $pt = 0.00424746$
 $pc = 0.00424746$
 $pv = 0.00150186$
 $N = 15251.406$
 $b = 750.00$
 $\alpha = 0.12044818$
 $y_{comp} = 2.7501333E-005$
 with $f_c = 33.00$
 $E_c = 26999.444$
 $y = 0.22408338$
 $A = 0.00986732$
 $B = 0.00560044$

with $E_s = 200000.00$

Calculation of ratio I_b/I_d

Inadequate Lap Length with $I_b/I_d = 0.30$

End Of Calculation of Shear Capacity for element: column JC1 of floor 1

At local axis: 3

Integration Section: (a)

Calculation No. 12

column C1, Floor 1

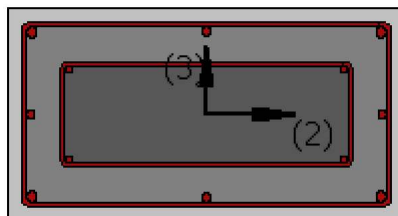
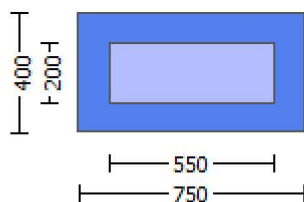
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (ϕ)

Edge: Start

Local Axis: (3)



Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjrs

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 33.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.56$

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 20.00$
 Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 444.44$
 Concrete Elasticity, $E_c = 21019.039$
 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, $f_s = 1.25 \cdot f_{sm} = 694.45$
 Existing Column
 Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 555.55$
 #####
 External Height, $H = 400.00$
 External Width, $W = 750.00$
 Internal Height, $H = 200.00$
 Internal Width, $W = 550.00$
 Cover Thickness, $c = 25.00$
 Mean Confinement Factor overall section = 1.00
 Element Length, $L = 3000.00$
 Secondary Member
 Ribbed Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Inadequate Lap Length with $l_o/l_{ou,min} = 0.30$
 No FRP Wrapping

----- Stepwise Properties -----

At local axis: 3
 EDGE -A-
 Shear Force, $V_a = -1.3927229E-031$
 EDGE -B-
 Shear Force, $V_b = 1.3927229E-031$
 BOTH EDGES
 Axial Force, $F = -11016.808$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $As_t = 0.00$
 -Compression: $As_c = 2676.637$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten} = 1137.257$
 -Compression: $As_{c,com} = 1137.257$
 -Middle: $As_{mid} = 402.1239$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.19160863$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 115015.186$
 with
 $M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 1.7252E+008$
 $Mu_{1+} = 1.7252E+008$, 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
 $Mu_{1-} = 1.7252E+008$, 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
 $M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 1.7252E+008$
 $Mu_{2+} = 1.7252E+008$, 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
 $Mu_{2-} = 1.7252E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment
 direction which is defined for the the static loading combination

 Calculation of Mu_{1+}

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

$$u = 1.7214953E-005$$

$$Mu = 1.7252E+008$$

with full section properties:

$$b = 750.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00124684$$

$$N = 11016.808$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.0052143$$

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

$$\text{From (5.4b), TBDY: } \phi_u = 0.0052143$$

$$\omega_e (5.4c) = 0.00183676$$

$$a_{se} ((5.4d), \text{TBDY}) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.12601038$$

$$a_{se1} = 0.12601038$$

$$b_{o_1} = 690.00$$

$$h_{o_1} = 340.00$$

$$b_{i2_1} = 1.1834E+006$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.12601038$$

$$b_{o_2} = 542.00$$

$$h_{o_2} = 192.00$$

$$b_{i2_2} = 661256.00$$

$$p_{sh,min} * F_{ywe} = \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.60339$$

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)

$$p_{sh,x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.60339$$

$$p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.0020944$$

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

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

$$h_1 = 400.00$$

$$p_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00026808$$

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

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

$$h_2 = 200.00$$

$$p_{sh,y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 3.13667$$

$$p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00392699$$

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

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

$$h_1 = 750.00$$

$$p_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00073723$$

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

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

$$h_2 = 550.00$$

$$A_{sec} = 300000.00$$

$$s_1 = 100.00$$

$$s_2 = 250.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 555.55$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$f_{t1} = 441.5397$$

$$f_{y1} = 367.9498$$

$$su_1 = 0.00512$$

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

and also multiplied by the shear_factor according to 15.7.1.4, with

$$\text{Shear_factor} = 1.00$$

$$I_o / I_{ou,min} = I_b / I_d = 0.30$$

$su1 = 0.4 \cdot esu1_nominal ((5.5), TBDY) = 0.032$
 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 $Min(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs1 = (fs_jacket \cdot Asl_ten_jacket + fs_core \cdot Asl_ten_core) / Asl_ten = 367.9498$
 with $Es1 = (Es_jacket \cdot Asl_ten_jacket + Es_core \cdot Asl_ten_core) / Asl_ten = 200000.00$
 $y2 = 0.00140044$
 $sh2 = 0.0044814$
 $ft2 = 441.5397$
 $fy2 = 367.9498$
 $su2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou, min = lb/lb, min = 0.30$
 $su2 = 0.4 \cdot esu2_nominal ((5.5), TBDY) = 0.032$
 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 $fs2 = (fs_jacket \cdot Asl_com_jacket + fs_core \cdot Asl_com_core) / Asl_com = 367.9498$
 with $Es2 = (Es_jacket \cdot Asl_com_jacket + Es_core \cdot Asl_com_core) / Asl_com = 200000.00$
 $yv = 0.00140044$
 $shv = 0.0044814$
 $ftv = 466.8167$
 $fyv = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou, min = lb/ld = 0.30$
 $suv = 0.4 \cdot esuv_nominal ((5.5), TBDY) = 0.032$
 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 $fsv = (fs_jacket \cdot Asl_mid_jacket + fs_mid \cdot Asl_mid_core) / Asl_mid = 389.0139$
 with $Es_v = (Es_jacket \cdot Asl_mid_jacket + Es_mid \cdot Asl_mid_core) / Asl_mid = 200000.00$
 $1 = Asl_ten / (b \cdot d) \cdot (fs1 / fc) = 0.04735912$
 $2 = Asl_com / (b \cdot d) \cdot (fs2 / fc) = 0.04735912$
 $v = Asl_mid / (b \cdot d) \cdot (fsv / fc) = 0.01770442$

and confined core properties:

$b = 690.00$
 $d = 327.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl_ten / (b \cdot d) \cdot (fs1 / fc) = 0.05619999$
 $2 = Asl_com / (b \cdot d) \cdot (fs2 / fc) = 0.05619999$
 $v = Asl_mid / (b \cdot d) \cdot (fsv / fc) = 0.02100943$

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

--->
 $v < vs, y2$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.16690234$
 $Mu = MRc (4.14) = 1.7252E+008$
 $u = su (4.1) = 1.7214953E-005$

Calculation of ratio lb/ld

Inadequate Lap Length with $lb/ld = 0.30$

Calculation of Mu1-

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

$$\mu = 1.7214953E-005$$

$$\mu_u = 1.7252E+008$$

with full section properties:

$$b = 750.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00124684$$

$$N = 11016.808$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu_u: \mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, \alpha) = 0.0052143$$

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

$$\text{From (5.4b), TB DY: } \mu_u = 0.0052143$$

$$\mu_{ue} (5.4c) = 0.00183676$$

$$\mu_{se} ((5.4d), \text{TB DY}) = (\mu_{se1} * A_{ext} + \mu_{se2} * A_{int}) / A_{sec} = 0.12601038$$

$$\mu_{se1} = 0.12601038$$

$$b_{o_1} = 690.00$$

$$h_{o_1} = 340.00$$

$$b_{i2_1} = 1.1834E+006$$

$$\mu_{se2} = \text{Max}(\mu_{se1}, \mu_{se2}) = 0.12601038$$

$$b_{o_2} = 542.00$$

$$h_{o_2} = 192.00$$

$$b_{i2_2} = 661256.00$$

$$\mu_{sh, \min} * F_{ywe} = \text{Min}(\mu_{sh, x} * F_{ywe}, \mu_{sh, y} * F_{ywe}) = 1.60339$$

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)

$$\mu_{sh, x} * F_{ywe} = \mu_{sh1} * F_{ywe1} + \mu_{sh2} * F_{ywe2} = 1.60339$$

$$\mu_{sh1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.0020944$$

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

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

$$h_1 = 400.00$$

$$\mu_{sh2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00026808$$

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

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

$$h_2 = 200.00$$

$$\mu_{sh, y} * F_{ywe} = \mu_{sh1} * F_{ywe1} + \mu_{sh2} * F_{ywe2} = 3.13667$$

$$\mu_{sh1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00392699$$

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

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

$$h_1 = 750.00$$

$$\mu_{sh2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00073723$$

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

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

$$h_2 = 550.00$$

$$A_{sec} = 300000.00$$

$$s_1 = 100.00$$

$$s_2 = 250.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 555.55$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$s_{h1} = 0.0044814$$

$$f_{t1} = 441.5397$$

$$f_{y1} = 367.9498$$

```

su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 367.9498
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 441.5397
fy2 = 367.9498
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 367.9498
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04735912
2 = Asl,com/(b*d)*(fs2/fc) = 0.04735912
v = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05619999
2 = Asl,com/(b*d)*(fs2/fc) = 0.05619999
v = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.16690234
Mu = MRc (4.14) = 1.7252E+008
u = su (4.1) = 1.7214953E-005

```

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of μ_{2+}

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

$\mu_u = 1.7214953E-005$

$\mu_{2+} = 1.7252E+008$

with full section properties:

$b = 750.00$

$d = 357.00$

$d' = 43.00$

$v = 0.00124684$

$N = 11016.808$

$f_c = 33.00$

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

Final value of μ_{cu} : $\mu_{cu}^* = \text{shear_factor} * \text{Max}(\mu_{cu}, \mu_{cc}) = 0.0052143$

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

From (5.4b), TBDY: $\mu_{cu} = 0.0052143$

μ_{we} (5.4c) = 0.00183676

μ_{ase} ((5.4d), TBDY) = $(\mu_{ase1} * A_{ext} + \mu_{ase2} * A_{int}) / A_{sec} = 0.12601038$

$\mu_{ase1} = 0.12601038$

$b_{o_1} = 690.00$

$h_{o_1} = 340.00$

$b_{i2_1} = 1.1834E+006$

$\mu_{ase2} = \text{Max}(\mu_{ase1}, \mu_{ase2}) = 0.12601038$

$b_{o_2} = 542.00$

$h_{o_2} = 192.00$

$b_{i2_2} = 661256.00$

$\mu_{psh,min} * F_{ywe} = \text{Min}(\mu_{psh,x} * F_{ywe}, \mu_{psh,y} * F_{ywe}) = 1.60339$

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)

$\mu_{psh,x} * F_{ywe} = \mu_{psh1} * F_{ywe1} + \mu_{ps2} * F_{ywe2} = 1.60339$

μ_{ps1} (external) = $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.0020944$

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

No stirrups, $n_{s_1} = 2.00$

$h_1 = 400.00$

μ_{ps2} (internal) = $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00026808$

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

No stirrups, $n_{s_2} = 2.00$

$h_2 = 200.00$

$\mu_{psh,y} * F_{ywe} = \mu_{psh1} * F_{ywe1} + \mu_{ps2} * F_{ywe2} = 3.13667$

μ_{ps1} (external) = $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00392699$

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

No stirrups, $n_{s_1} = 2.00$

$h_1 = 750.00$

μ_{ps2} (internal) = $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00073723$

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

No stirrups, $n_{s_2} = 2.00$

$h_2 = 550.00$

$A_{sec} = 300000.00$

$s_1 = 100.00$

$s_2 = 250.00$

$f_{ywe1} = 694.45$

$f_{ywe2} = 555.55$

$f_{ce} = 33.00$

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

```

c = confinement factor = 1.00
y1 = 0.00140044
sh1 = 0.0044814
ft1 = 441.5397
fy1 = 367.9498
su1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 367.9498
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 441.5397
fy2 = 367.9498
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 367.9498
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04735912
2 = Asl,com/(b*d)*(fs2/fc) = 0.04735912
v = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05619999
2 = Asl,com/(b*d)*(fs2/fc) = 0.05619999
v = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied

```

--->

$$su(4.9) = 0.16690234$$

$$Mu = MRc(4.14) = 1.7252E+008$$

$$u = su(4.1) = 1.7214953E-005$$

Calculation of ratio lb/ld

Inadequate Lap Length with $lb/ld = 0.30$

Calculation of $Mu2$ -

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

$$u = 1.7214953E-005$$

$$Mu = 1.7252E+008$$

with full section properties:

$$b = 750.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00124684$$

$$N = 11016.808$$

$$fc = 33.00$$

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

$$\text{Final value of } cu: cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0052143$$

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

$$\text{From (5.4b), TBDY: } cu = 0.0052143$$

$$we(5.4c) = 0.00183676$$

$$ase((5.4d), TBDY) = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.12601038$$

$$ase1 = 0.12601038$$

$$bo_1 = 690.00$$

$$ho_1 = 340.00$$

$$bi2_1 = 1.1834E+006$$

$$ase2 = \text{Max}(ase1, ase2) = 0.12601038$$

$$bo_2 = 542.00$$

$$ho_2 = 192.00$$

$$bi2_2 = 661256.00$$

$$psh, \min * F_{ywe} = \text{Min}(psh, x * F_{ywe}, psh, y * F_{ywe}) = 1.60339$$

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)

$$psh, x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.60339$$

$$ps1(\text{external}) = (Ash1 * h1 / s1) / A_{sec} = 0.0020944$$

$$Ash1 = Astir_1 * ns_1 = 157.0796$$

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

$$h1 = 400.00$$

$$ps2(\text{internal}) = (Ash2 * h2 / s2) / A_{sec} = 0.00026808$$

$$Ash2 = Astir_2 * ns_2 = 100.531$$

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

$$h2 = 200.00$$

$$psh, y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 3.13667$$

$$ps1(\text{external}) = (Ash1 * h1 / s1) / A_{sec} = 0.00392699$$

$$Ash1 = Astir_1 * ns_1 = 157.0796$$

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

$$h1 = 750.00$$

$$ps2(\text{internal}) = (Ash2 * h2 / s2) / A_{sec} = 0.00073723$$

$$Ash2 = Astir_2 * ns_2 = 100.531$$

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

$$h2 = 550.00$$

$$A_{sec} = 300000.00$$

$$s1 = 100.00$$

$s_2 = 250.00$
 $fy_{w1} = 694.45$
 $fy_{w2} = 555.55$
 $f_{ce} = 33.00$
 From ((5A.5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$
 $y_1 = 0.00140044$
 $sh_1 = 0.0044814$
 $ft_1 = 441.5397$
 $fy_1 = 367.9498$
 $su_1 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou, \min = lb/ld = 0.30$
 $su_1 = 0.4 * esu_1 \text{ nominal } ((5.5), \text{TBDY}) = 0.032$
 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 $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_1 = (fs_{\text{jacket}} * A_{sl, \text{ten, jacket}} + fs_{\text{core}} * A_{sl, \text{ten, core}}) / A_{sl, \text{ten}} = 367.9498$
 with $Es_1 = (Es_{\text{jacket}} * A_{sl, \text{ten, jacket}} + Es_{\text{core}} * A_{sl, \text{ten, core}}) / A_{sl, \text{ten}} = 200000.00$
 $y_2 = 0.00140044$
 $sh_2 = 0.0044814$
 $ft_2 = 441.5397$
 $fy_2 = 367.9498$
 $su_2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou, \min = lb/lb, \min = 0.30$
 $su_2 = 0.4 * esu_2 \text{ nominal } ((5.5), \text{TBDY}) = 0.032$
 From table 5A.1, TBDY: $esu_2 \text{ nominal} = 0.08$,
 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, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = (fs_{\text{jacket}} * A_{sl, \text{com, jacket}} + fs_{\text{core}} * A_{sl, \text{com, core}}) / A_{sl, \text{com}} = 367.9498$
 with $Es_2 = (Es_{\text{jacket}} * A_{sl, \text{com, jacket}} + Es_{\text{core}} * A_{sl, \text{com, core}}) / A_{sl, \text{com}} = 200000.00$
 $y_v = 0.00140044$
 $sh_v = 0.0044814$
 $ft_v = 466.8167$
 $fy_v = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou, \min = lb/ld = 0.30$
 $suv = 0.4 * esuv \text{ nominal } ((5.5), \text{TBDY}) = 0.032$
 From table 5A.1, TBDY: $esuv \text{ nominal} = 0.08$,
 considering characteristic value $fsyv = fs_v/1.2$, from table 5.1, TBDY
 For calculation of $esuv \text{ nominal}$ 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 $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_v = (fs_{\text{jacket}} * A_{sl, \text{mid, jacket}} + fs_{\text{mid}} * A_{sl, \text{mid, core}}) / A_{sl, \text{mid}} = 389.0139$
 with $Es_v = (Es_{\text{jacket}} * A_{sl, \text{mid, jacket}} + Es_{\text{mid}} * A_{sl, \text{mid, core}}) / A_{sl, \text{mid}} = 200000.00$
 $1 = A_{sl, \text{ten}} / (b * d) * (fs_1 / f_c) = 0.04735912$
 $2 = A_{sl, \text{com}} / (b * d) * (fs_2 / f_c) = 0.04735912$
 $v = A_{sl, \text{mid}} / (b * d) * (fs_v / f_c) = 0.01770442$
 and confined core properties:
 $b = 690.00$
 $d = 327.00$
 $d' = 13.00$
 $f_{cc} (5A.2, \text{TBDY}) = 33.00$
 $cc (5A.5, \text{TBDY}) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl, \text{ten}} / (b * d) * (fs_1 / f_c) = 0.05619999$
 $2 = A_{sl, \text{com}} / (b * d) * (fs_2 / f_c) = 0.05619999$

$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.02100943$
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)

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

--->
 $\mu_u(4.9) = 0.16690234$
 $\mu_u = M_{Rc}(4.14) = 1.7252E+008$
 $u = \mu_u(4.1) = 1.7214953E-005$

Calculation of ratio I_b/I_d

Inadequate Lap Length with $I_b/I_d = 0.30$

Calculation of Shear Strength $V_r = \min(V_{r1}, V_{r2}) = 600261.003$

Calculation of Shear Strength at edge 1, $V_{r1} = 600261.003$

$V_{r1} = V_{Col}((10.3), ASCE 41-17) = k_{nl} * V_{Col0}$

$V_{Col0} = 600261.003$

$k_{nl} = 1$ (zero step-static loading)

NOTE: In expression (10-3) ' $V_s = A_v * f_y * d / s$ ' is replaced by ' $V_s + f * V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

= 1 (normal-weight concrete)

Mean concrete strength: $f'_c = (f'_c_{jacket} * Area_{jacket} + f'_c_{core} * Area_{core}) / Area_{section} = 28.23333$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$M/Vd = 2.00$

$\mu_u = 1.0002017E-011$

$V_u = 1.3927229E-031$

$d = 0.8 * h = 320.00$

$N_u = 11016.808$

$A_g = 300000.00$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} = 279254.914$

where:

$V_{s1} = 279254.914$ is calculated for jacket, with:

$d = 320.00$

$A_v = 157079.633$

$f_y = 555.56$

$s = 100.00$

V_{s1} is multiplied by $Col1 = 1.00$

$s/d = 0.3125$

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

$d = 160.00$

$A_v = 100530.965$

$f_y = 444.44$

$s = 250.00$

V_{s2} is multiplied by $Col2 = 0.00$

$s/d = 1.5625$

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

From (11-11), ACI 440: $V_s + V_f \leq 847147.582$

$b_w = 750.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 600261.003$

$V_{r2} = V_{Col}((10.3), ASCE 41-17) = k_{nl} * V_{Col0}$

$V_{Col0} = 600261.003$

$k_{nl} = 1$ (zero step-static loading)

NOTE: In expression (10-3) ' $V_s = A_v * f_y * d / s$ ' is replaced by ' $V_s + f * V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

= 1 (normal-weight concrete)

Mean concrete strength: $f_c' = (f_c'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f_c'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 28.23333$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$M/Vd = 2.00$

$\mu_u = 1.0002017\text{E}-011$

$\nu_u = 1.3927229\text{E}-031$

$d = 0.8 \cdot h = 320.00$

$N_u = 11016.808$

$A_g = 300000.00$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} = 279254.914$

where:

$V_{s1} = 279254.914$ is calculated for jacket, with:

$d = 320.00$

$A_v = 157079.633$

$f_y = 555.56$

$s = 100.00$

V_{s1} is multiplied by $\text{Col1} = 1.00$

$s/d = 0.3125$

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

$d = 160.00$

$A_v = 100530.965$

$f_y = 444.44$

$s = 250.00$

V_{s2} is multiplied by $\text{Col2} = 0.00$

$s/d = 1.5625$

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

From (11-11), ACI 440: $V_s + V_f \leq 847147.582$

$b_w = 750.00$

End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1

At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1

At Shear local axis: 2

(Bending local axis: 3)

Section Type: rcjrs

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 33.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.56$

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 20.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 444.44$

Concrete Elasticity, $E_c = 21019.039$

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, $f_s = 1.25 \cdot f_{sm} = 694.45$

Existing Column

Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 555.55$

#####

External Height, $H = 400.00$

External Width, $W = 750.00$

Internal Height, $H = 200.00$

Internal Width, $W = 550.00$

Cover Thickness, $c = 25.00$
 Mean Confinement Factor overall section = 1.00
 Element Length, $L = 3000.00$
 Secondary Member
 Ribbed Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Inadequate Lap Length with $l_o/l_{o,min} = 0.30$
 No FRP Wrapping

Stepwise Properties

At local axis: 2
 EDGE -A-
 Shear Force, $V_a = -3.9443045E-031$
 EDGE -B-
 Shear Force, $V_b = 3.9443045E-031$
 BOTH EDGES
 Axial Force, $F = -11016.808$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $As_t = 0.00$
 -Compression: $As_c = 2676.637$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten} = 1137.257$
 -Compression: $As_{c,com} = 1137.257$
 -Middle: $As_{mid} = 402.1239$

Calculation of Shear Capacity ratio , $V_e/V_r = 0.25537128$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 235770.47$
 with
 $M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 3.5366E+008$
 $\mu_{u1+} = 3.5366E+008$, 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
 $\mu_{u1-} = 3.5366E+008$, 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
 $M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 3.5366E+008$
 $\mu_{u2+} = 3.5366E+008$, 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
 $\mu_{u2-} = 3.5366E+008$, 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

Calculation of μ_{u1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 8.5738376E-006$
 $\mu_u = 3.5366E+008$

with full section properties:

$b = 400.00$
 $d = 707.00$
 $d' = 43.00$
 $v = 0.00118049$
 $N = 11016.808$
 $f_c = 33.00$
 ϕ_o (5A.5, TBDY) = 0.002
 Final value of ϕ_u : $\phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_o) = 0.0052143$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $\phi_u = 0.0052143$

$w_e (5.4c) = 0.00183676$
 $ase ((5.4d), TBDY) = (ase1 \cdot A_{ext} + ase2 \cdot A_{int}) / A_{sec} = 0.12601038$
 $ase1 = 0.12601038$
 $bo_1 = 690.00$
 $ho_1 = 340.00$
 $bi2_1 = 1.1834E+006$
 $ase2 = \text{Max}(ase1, ase2) = 0.12601038$
 $bo_2 = 542.00$
 $ho_2 = 192.00$
 $bi2_2 = 661256.00$
 $psh, \min \cdot F_{ywe} = \text{Min}(psh, x \cdot F_{ywe}, psh, y \cdot F_{ywe}) = 1.60339$
 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)

$psh, x \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 1.60339$
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / A_{sec} = 0.0020944$
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / A_{sec} = 0.00026808$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

$psh, y \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 3.13667$
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / A_{sec} = 0.00392699$
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 750.00$
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / A_{sec} = 0.00073723$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 550.00$

$A_{sec} = 300000.00$
 $s1 = 100.00$
 $s2 = 250.00$
 $fywe1 = 694.45$
 $fywe2 = 555.55$
 $f_{ce} = 33.00$
 From ((5.A5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$
 $y1 = 0.00140044$
 $sh1 = 0.0044814$
 $ft1 = 441.5397$
 $fy1 = 367.9498$
 $su1 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lo, \min = lb/ld = 0.30$
 $su1 = 0.4 \cdot esu1_nominal ((5.5), TBDY) = 0.032$
 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 $fs1 = (fs, \text{jacket} \cdot A_{sl, \text{ten, jacket}} + fs, \text{core} \cdot A_{sl, \text{ten, core}}) / A_{sl, \text{ten}} = 367.9498$
 with $Es1 = (Es, \text{jacket} \cdot A_{sl, \text{ten, jacket}} + Es, \text{core} \cdot A_{sl, \text{ten, core}}) / A_{sl, \text{ten}} = 200000.00$
 $y2 = 0.00140044$
 $sh2 = 0.0044814$
 $ft2 = 441.5397$
 $fy2 = 367.9498$
 $su2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lo, \min = lb/lb, \min = 0.30$

```

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 367.9498
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/d = 0.30
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04483877
2 = Asl,com/(b*d)*(fs2/fc) = 0.04483877
v = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05508907
2 = Asl,com/(b*d)*(fs2/fc) = 0.05508907
v = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.1553529
Mu = MRc (4.14) = 3.5366E+008
u = su (4.1) = 8.5738376E-006

```

Calculation of ratio lb/d

Inadequate Lap Length with lb/d = 0.30

Calculation of Mu1-

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

u = 8.5738376E-006
Mu = 3.5366E+008

with full section properties:

b = 400.00
d = 707.00
d' = 43.00
v = 0.00118049
N = 11016.808

$f_c = 33.00$
 $c_o (5A.5, TBDY) = 0.002$
 Final value of c_u : $c_u^* = \text{shear_factor} * \text{Max}(c_u, c_o) = 0.0052143$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $c_u = 0.0052143$
 $w_e (5.4c) = 0.00183676$
 $a_{se} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.12601038$
 $a_{se1} = 0.12601038$
 $b_o_1 = 690.00$
 $h_o_1 = 340.00$
 $b_{i2_1} = 1.1834E+006$
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.12601038$
 $b_o_2 = 542.00$
 $h_o_2 = 192.00$
 $b_{i2_2} = 661256.00$
 $p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.60339$
 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)

$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.60339$
 $p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.0020944$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h_1 = 400.00$
 $p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00026808$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirrups, $n_{s_2} = 2.00$
 $h_2 = 200.00$

$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 3.13667$
 $p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00392699$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h_1 = 750.00$
 $p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00073723$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirrups, $n_{s_2} = 2.00$
 $h_2 = 550.00$

$A_{sec} = 300000.00$
 $s_1 = 100.00$
 $s_2 = 250.00$
 $f_{ywe1} = 694.45$
 $f_{ywe2} = 555.55$
 $f_{ce} = 33.00$

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

$y_1 = 0.00140044$
 $sh_1 = 0.0044814$
 $ft_1 = 441.5397$
 $fy_1 = 367.9498$
 $su_1 = 0.00512$

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

$l_o / l_{ou, \min} = l_b / l_d = 0.30$

$su_1 = 0.4 * e_{su1_nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $e_{su1_nominal} = 0.08$

For calculation of $e_{su1_nominal}$ 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 $fs_1 = (f_{s, \text{jacket}} * A_{sl, \text{ten, jacket}} + f_{s, \text{core}} * A_{sl, \text{ten, core}}) / A_{sl, \text{ten}} = 367.9498$

with $E_{s1} = (E_{s, \text{jacket}} * A_{sl, \text{ten, jacket}} + E_{s, \text{core}} * A_{sl, \text{ten, core}}) / A_{sl, \text{ten}} = 200000.00$

$y_2 = 0.00140044$
 $sh_2 = 0.0044814$
 $ft_2 = 441.5397$
 $fy_2 = 367.9498$

```

su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 367.9498
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.30
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04483877
2 = Asl,com/(b*d)*(fs2/fc) = 0.04483877
v = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05508907
2 = Asl,com/(b*d)*(fs2/fc) = 0.05508907
v = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.1553529
Mu = MRc (4.14) = 3.5366E+008
u = su (4.1) = 8.5738376E-006

```

Calculation of ratio lb/lb

Inadequate Lap Length with lb/lb = 0.30

Calculation of Mu2+

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

u = 8.5738376E-006
Mu = 3.5366E+008

with full section properties:

$b = 400.00$
 $d = 707.00$
 $d' = 43.00$
 $v = 0.00118049$
 $N = 11016.808$
 $f_c = 33.00$
 $\phi (5A.5, \text{TB DY}) = 0.002$
 Final value of ϕ : $\phi^* = \text{shear_factor} * \text{Max}(\phi, \phi_c) = 0.0052143$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TB DY: $\phi = 0.0052143$
 $\phi (5.4c) = 0.00183676$
 $\phi (5.4d), \text{TB DY} = (\phi_1 * A_{ext} + \phi_2 * A_{int}) / A_{sec} = 0.12601038$
 $\phi_1 = 0.12601038$
 $b_o_1 = 690.00$
 $h_o_1 = 340.00$
 $b_{i2_1} = 1.1834E+006$
 $\phi_2 = \text{Max}(\phi_1, \phi_2) = 0.12601038$
 $b_o_2 = 542.00$
 $h_o_2 = 192.00$
 $b_{i2_2} = 661256.00$
 $\phi_{sh,min} * F_{ywe} = \text{Min}(\phi_{sh,x} * F_{ywe}, \phi_{sh,y} * F_{ywe}) = 1.60339$
 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)

$\phi_{sh,x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.60339$
 $\phi_{sh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.0020944$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h_1 = 400.00$
 $\phi_{sh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00026808$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirrups, $n_{s_2} = 2.00$
 $h_2 = 200.00$

$\phi_{sh,y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 3.13667$
 $\phi_{sh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00392699$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h_1 = 750.00$
 $\phi_{sh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00073723$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirrups, $n_{s_2} = 2.00$
 $h_2 = 550.00$

$A_{sec} = 300000.00$
 $s_1 = 100.00$
 $s_2 = 250.00$
 $f_{ywe1} = 694.45$
 $f_{ywe2} = 555.55$
 $f_{ce} = 33.00$
 From ((5.A5), TB DY), TB DY: $\phi_c = 0.002$
 $\phi_c = \text{confinement factor} = 1.00$
 $\phi_1 = 0.00140044$
 $\phi_{sh1} = 0.0044814$
 $\phi_{t1} = 441.5397$
 $\phi_{y1} = 367.9498$
 $\phi_{s1} = 0.00512$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $\phi_o / \phi_{ou,min} = \phi_b / \phi_d = 0.30$
 $\phi_{s1} = 0.4 * \phi_{su1_nominal} ((5.5), \text{TB DY}) = 0.032$
 From table 5A.1, TB DY: $\phi_{su1_nominal} = 0.08$,
 For calculation of $\phi_{su1_nominal}$ and $\phi_1, \phi_{sh1}, \phi_{t1}, \phi_{y1}$, it is considered
 characteristic value $\phi_{s1} = \phi_{s1} / 1.2$, from table 5.1, TB DY.
 $\phi_1, \phi_{sh1}, \phi_{t1}, \phi_{y1}$, are also multiplied by $\text{Min}(1, 1.25 * (\phi_b / \phi_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $\phi_{s1} = (\phi_{s,jacket} * A_{s,ten,jacket} + \phi_{s,core} * A_{s,ten,core}) / A_{s,ten} = 367.9498$

```

with Es1 = (Esjacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 441.5397
fy2 = 367.9498
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 367.9498
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.30
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04483877
2 = Asl,com/(b*d)*(fs2/fc) = 0.04483877
v = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05508907
2 = Asl,com/(b*d)*(fs2/fc) = 0.05508907
v = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.1553529
Mu = MRc (4.14) = 3.5366E+008
u = su (4.1) = 8.5738376E-006

```

Calculation of ratio lb/lb

Inadequate Lap Length with lb/lb = 0.30

Calculation of Mu2-

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

$$\phi_u = 8.5738376E-006$$

$$M_u = 3.5366E+008$$

with full section properties:

$$b = 400.00$$

$$d = 707.00$$

$$d' = 43.00$$

$$v = 0.00118049$$

$$N = 11016.808$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.0052143$$

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

$$\text{From (5.4b), TBDY: } \phi_u = 0.0052143$$

$$\omega_e (5.4c) = 0.00183676$$

$$a_{se} ((5.4d), \text{TBDY}) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.12601038$$

$$a_{se1} = 0.12601038$$

$$b_{o_1} = 690.00$$

$$h_{o_1} = 340.00$$

$$b_{i2_1} = 1.1834E+006$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.12601038$$

$$b_{o_2} = 542.00$$

$$h_{o_2} = 192.00$$

$$b_{i2_2} = 661256.00$$

$$\text{psh_min} * F_{ywe} = \text{Min}(\text{psh_x} * F_{ywe}, \text{psh_y} * F_{ywe}) = 1.60339$$

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)

$$\text{psh_x} * F_{ywe} = \text{psh}_1 * F_{ywe1} + \text{ps}_2 * F_{ywe2} = 1.60339$$

$$\text{ps}_1 (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.0020944$$

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

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

$$h_1 = 400.00$$

$$\text{ps}_2 (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00026808$$

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

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

$$h_2 = 200.00$$

$$\text{psh_y} * F_{ywe} = \text{psh}_1 * F_{ywe1} + \text{ps}_2 * F_{ywe2} = 3.13667$$

$$\text{ps}_1 (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00392699$$

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

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

$$h_1 = 750.00$$

$$\text{ps}_2 (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00073723$$

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

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

$$h_2 = 550.00$$

$$A_{sec} = 300000.00$$

$$s_1 = 100.00$$

$$s_2 = 250.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 555.55$$

$$f_{ce} = 33.00$$

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

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

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 441.5397$$

$$fy_1 = 367.9498$$

$$su_1 = 0.00512$$

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

and also multiplied by the shear_factor according to 15.7.1.4, with

$$\text{Shear_factor} = 1.00$$

$$l_o / l_{ou, \text{min}} = l_b / l_d = 0.30$$

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

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 $fs1 = (fs_jacket \cdot Asl_ten_jacket + fs_core \cdot Asl_ten_core) / Asl_ten = 367.9498$
with $Es1 = (Es_jacket \cdot Asl_ten_jacket + Es_core \cdot Asl_ten_core) / Asl_ten = 200000.00$
 $y2 = 0.00140044$
 $sh2 = 0.0044814$
 $ft2 = 441.5397$
 $fy2 = 367.9498$
 $su2 = 0.00512$
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $lo/lou, min = lb/lb, min = 0.30$
 $su2 = 0.4 \cdot esu2_nominal \cdot ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esu2_nominal = 0.08$,
For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is 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 $fs2 = (fs_jacket \cdot Asl_com_jacket + fs_core \cdot Asl_com_core) / Asl_com = 367.9498$
with $Es2 = (Es_jacket \cdot Asl_com_jacket + Es_core \cdot Asl_com_core) / Asl_com = 200000.00$
 $yv = 0.00140044$
 $shv = 0.0044814$
 $ftv = 466.8167$
 $fyv = 389.0139$
 $suv = 0.00512$
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $lo/lou, min = lb/ld = 0.30$
 $suv = 0.4 \cdot esuv_nominal \cdot ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esuv_nominal = 0.08$,
considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is 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 $fsv = (fs_jacket \cdot Asl_mid_jacket + fs_mid \cdot Asl_mid_core) / Asl_mid = 389.0139$
with $Es_v = (Es_jacket \cdot Asl_mid_jacket + Es_mid \cdot Asl_mid_core) / Asl_mid = 200000.00$
 $1 = Asl_ten / (b \cdot d) \cdot (fs1 / fc) = 0.04483877$
 $2 = Asl_com / (b \cdot d) \cdot (fs2 / fc) = 0.04483877$
 $v = Asl_mid / (b \cdot d) \cdot (fsv / fc) = 0.01676222$
and confined core properties:
 $b = 340.00$
 $d = 677.00$
 $d' = 13.00$
 fcc (5A.2, TBDY) = 33.00
 cc (5A.5, TBDY) = 0.002
 c = confinement factor = 1.00
 $1 = Asl_ten / (b \cdot d) \cdot (fs1 / fc) = 0.05508907$
 $2 = Asl_com / (b \cdot d) \cdot (fs2 / fc) = 0.05508907$
 $v = Asl_mid / (b \cdot d) \cdot (fsv / fc) = 0.02059413$
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
 $v < vs, y2$ - LHS eq.(4.5) is satisfied
--->
 su (4.9) = 0.1553529
 $Mu = MRc$ (4.14) = 3.5366E+008
 $u = su$ (4.1) = 8.5738376E-006

Calculation of ratio lb/ld

Inadequate Lap Length with $lb/ld = 0.30$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 923245.821$

Calculation of Shear Strength at edge 1, $V_{r1} = 923245.821$

$V_{r1} = V_{col} \text{ ((10.3), ASCE 41-17)} = k_{nl} * V_{col0}$

$V_{col0} = 923245.821$

$k_{nl} = 1$ (zero step-static loading)

NOTE: In expression (10-3) ' $V_s = A_v * f_y * d / s$ ' is replaced by ' $V_s + f * V_f$ ' where V_f is the contribution of FRPs (11.3), ACI 440).

$= 1$ (normal-weight concrete)

Mean concrete strength: $f_c' = (f_c'_{\text{jacket}} * \text{Area}_{\text{jacket}} + f_c'_{\text{core}} * \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 28.23333$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$M / Vd = 2.00$

$\mu_u = 6.8236829\text{E-}012$

$\nu_u = 3.9443045\text{E-}031$

$d = 0.8 * h = 600.00$

$N_u = 11016.808$

$A_g = 300000.00$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} = 602239.733$

where:

$V_{s1} = 523602.964$ is calculated for jacket, with:

$d = 600.00$

$A_v = 157079.633$

$f_y = 555.56$

$s = 100.00$

V_{s1} is multiplied by $\text{Col1} = 1.00$

$s/d = 0.16666667$

$V_{s2} = 78636.768$ is calculated for core, with:

$d = 440.00$

$A_v = 100530.965$

$f_y = 444.44$

$s = 250.00$

V_{s2} is multiplied by $\text{Col2} = 1.00$

$s/d = 0.56818182$

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

From (11-11), ACI 440: $V_s + V_f \leq 847147.582$

$b_w = 400.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 923245.821$

$V_{r2} = V_{col} \text{ ((10.3), ASCE 41-17)} = k_{nl} * V_{col0}$

$V_{col0} = 923245.821$

$k_{nl} = 1$ (zero step-static loading)

NOTE: In expression (10-3) ' $V_s = A_v * f_y * d / s$ ' is replaced by ' $V_s + f * V_f$ ' where V_f is the contribution of FRPs (11.3), ACI 440).

$= 1$ (normal-weight concrete)

Mean concrete strength: $f_c' = (f_c'_{\text{jacket}} * \text{Area}_{\text{jacket}} + f_c'_{\text{core}} * \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 28.23333$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$M / Vd = 2.00$

$\mu_u = 6.8236829\text{E-}012$

$\nu_u = 3.9443045\text{E-}031$

$d = 0.8 * h = 600.00$

$N_u = 11016.808$

$A_g = 300000.00$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} = 602239.733$

where:

$V_{s1} = 523602.964$ is calculated for jacket, with:

$d = 600.00$

$A_v = 157079.633$

$f_y = 555.56$

$s = 100.00$

V_{s1} is multiplied by $\text{Col1} = 1.00$

$s/d = 0.16666667$

Vs2 = 78636.768 is calculated for core, with:

$d = 440.00$

$A_v = 100530.965$

$f_y = 444.44$

$s = 250.00$

Vs2 is multiplied by Col2 = 1.00

$s/d = 0.56818182$

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

From (11-11), ACI 440: $V_s + V_f \leq 847147.582$

$b_w = 400.00$

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

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

Constant Properties

Knowledge Factor, $= 1.00$

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, $f_c = f_{cm} = 33.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.56$

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 20.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 444.44$

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

External Height, $H = 400.00$

External Width, $W = 750.00$

Internal Height, $H = 200.00$

Internal Width, $W = 550.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_b/l_d = 0.30$

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = -9.7390E+006$

Shear Force, $V_2 = -2823.172$

Shear Force, $V_3 = -3.1363135E-013$

Axial Force, $F = -15251.406$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 0.00$

-Compression: $As_c = 2676.637$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten} = 1137.257$

-Compression: $As_{l,com} = 1137.257$

-Middle: $Asl_{mid} = 402.1239$
 Longitudinal External Reinforcement Area Distribution (in 3 divisions)
 -Tension: $Asl_{ten,jacket} = 829.3805$
 -Compression: $Asl_{com,jacket} = 829.3805$
 -Middle: $Asl_{mid,jacket} = 402.1239$
 Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $Asl_{ten,core} = 307.8761$
 -Compression: $Asl_{com,core} = 307.8761$
 -Middle: $Asl_{mid,core} = 0.00$
 Mean Diameter of Tension Reinforcement, $DbL = 16.80$

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = u = 0.0323797$
 $u = y + p = 0.0323797$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.00264439$ ((4.29), Biskinis Phd))
 $M_y = 2.5050E+008$
 $L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 3449.669
 From table 10.5, ASCE 41_17: $E_{eff} = factor * E_c * I_g = 1.0893E+014$
 $factor = 0.30$
 $A_g = 300000.00$
 Mean concrete strength: $fc' = (fc'_{jacket} * Area_{jacket} + fc'_{core} * Area_{core}) / Area_{section} = 28.23333$
 $N = 15251.406$
 $E_c * I_g = E_{c,jacket} * I_{g,jacket} + E_{c,core} * I_{g,core} = 3.6310E+014$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$
 $y_{ten} = 2.6754055E-006$
 with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25 * f_y * (l_b / d)^{2/3}) = 296.8915$
 $d = 707.00$
 $y = 0.21520049$
 $A = 0.00964642$
 $B = 0.00520186$
 with $pt = 0.00402142$
 $pc = 0.00402142$
 $pv = 0.00142194$
 $N = 15251.406$
 $b = 400.00$
 $" = 0.06082037$
 $y_{comp} = 1.4667378E-005$
 with $fc = 33.00$
 $E_c = 26999.444$
 $y = 0.21215815$
 $A = 0.0093422$
 $B = 0.00502021$
 with $E_s = 200000.00$

Calculation of ratio l_b / d

Inadequate Lap Length with $l_b / d = 0.30$

- Calculation of p -

From table 10-8: $p = 0.02973531$

with:

- Columns controlled by inadequate development or splicing along the clear height because $l_b/l_d < 1$

shear control ratio $V_{yE}/V_{Col0E} = 0.25537128$

$d = d_{external} = 707.00$

$s = s_{external} = 0.00$

$t = s_1 + s_2 + 2 \cdot t_f/bw \cdot (f_{fe}/f_s) = 0.00466422$

jacket: $s_1 = A_{v1} \cdot h_1 / (s_1 \cdot A_g) = 0.00392699$

$A_{v1} = 157.0796$, is the total area of all stirrups parallel to loading (shear) direction

$h_1 = 750.00$

$s_1 = 100.00$

core: $s_2 = A_{v2} \cdot h_2 / (s_2 \cdot A_g) = 0.00073723$

$A_{v2} = 100.531$, is the total area of all stirrups parallel to loading (shear) direction

$h_2 = 550.00$

$s_2 = 250.00$

The term $2 \cdot t_f/bw \cdot (f_{fe}/f_s)$ is implemented to account for FRP contribution

where $f = 2 \cdot t_f/bw$ is FRP ratio (EC8 - 3, A.4.4.3(6)) and f_{fe}/f_s normalises f to steel strength

All these variables have already been given in Shear control ratio calculation.

For the normalisation f_s of jacket is used.

$NUD = 15251.406$

$A_g = 300000.00$

$f_{cE} = (f_{c_jacket} \cdot Area_jacket + f_{c_core} \cdot Area_core) / section_area = 28.23333$

$f_{yE} = (f_{y_ext_Long_Reinf} \cdot Area_ext_Long_Reinf + f_{y_int_Long_Reinf} \cdot Area_int_Long_Reinf) / Area_Tot_Long_Rein = 529.9972$

$f_{yE} = (f_{y_ext_Trans_Reinf} \cdot s_1 + f_{y_int_Trans_Reinf} \cdot s_2) / (s_1 + s_2) = 537.9964$

$\rho_l = Area_Tot_Long_Rein / (b \cdot d) = 0.00946477$

$b = 400.00$

$d = 707.00$

$f_{cE} = 28.23333$

End Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1

At local axis: 3

Integration Section: (a)

Calculation No. 13

column C1, Floor 1

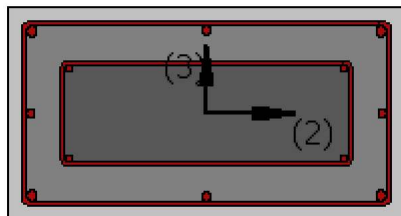
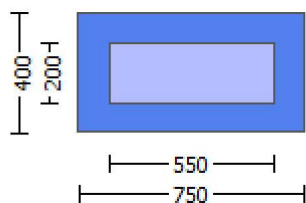
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: End

Local Axis: (2)



Start Of Calculation of Shear Capacity for element: column JC1 of floor 1

At local axis: 2

Integration Section: (b)

Section Type: rcjrs

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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, $f_c = f_{c_lower_bound} = 25.00$

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

Concrete Elasticity, $E_c = 26999.444$

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, $f_s = f_{s_lower_bound} = 400.00$

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of γ for displacement ductility demand, the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as Deformation-Controlled Action (Table C7-1, ASCE 41-17).

Jacket

New material: Concrete Strength, $f_c = f_{cm} = 33.00$

New material: Steel Strength, $f_s = f_{sm} = 555.56$

Existing Column

Existing material: Concrete Strength, $f_c = f_{cm} = 20.00$

Existing material: Steel Strength, $f_s = f_{sm} = 444.44$

#####

External Height, $H = 400.00$

External Width, $W = 750.00$

Internal Height, $H = 200.00$

Internal Width, $W = 550.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_o/l_{ou,min} = l_b/l_d = 0.30$

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = -9.7390E+006$

Shear Force, $V_a = -2823.172$

EDGE -B-

Bending Moment, Mb = 1.2625E+006

Shear Force, Vb = 2823.172

BOTH EDGES

Axial Force, F = -15251.406

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: Aslt = 0.00

-Compression: Aslc = 2676.637

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: Asl,ten = 1137.257

-Compression: Asl,com = 1137.257

-Middle: Asl,mid = 402.1239

Mean Diameter of Tension Reinforcement, DbL,ten = 16.80

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = $V_n = 824546.066$

V_n ((10.3), ASCE 41-17) = knl*VCol0 = 824546.066

VCol = 824546.066

knl = 1.00

displacement_ductility_demand = 0.04881574

NOTE: In expression (10-3) ' $V_s = A_v \cdot f_y \cdot d / s$ ' is replaced by ' $V_s + f \cdot V_f$ '
where V_f is the contribution of FRPs ((11.3), ACI 440).

= 1 (normal-weight concrete)

Mean concrete strength: $f_c' = (f_c'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f_c'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 21.70$, but $f_c'^{0.5} \leq 8.3$
MPa ((22.5.3.1, ACI 318-14)

M/Vd = 2.00

Mu = 1.2625E+006

Vu = 2823.172

d = 0.8*h = 600.00

Nu = 15251.406

Ag = 300000.00

From ((11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} = 542012.697$

where:

$V_{s1} = 471238.898$ is calculated for jacket, with:

d = 600.00

$A_v = 157079.633$

$f_y = 500.00$

s = 100.00

V_{s1} is multiplied by Col1 = 1.00

s/d = 0.16666667

$V_{s2} = 70773.799$ is calculated for core, with:

d = 440.00

$A_v = 100530.965$

$f_y = 400.00$

s = 250.00

V_{s2} is multiplied by Col2 = 1.00

s/d = 0.56818182

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

From ((11-11), ACI 440: $V_s + V_f \leq 742690.493$

bw = 400.00

displacement_ductility_demand is calculated as ϕ / y

- Calculation of ϕ / y for END B -

for rotation axis 3 and integ. section (b)

From analysis, chord rotation = 1.6733420E-005

$y = (M_y \cdot L_s / 3) / \text{Eleff} = 0.00034279$ ((4.29), Biskinis Phd))

$M_y = 2.5050E+008$

$L_s = M/V$ (with $L_s > 0.1 \cdot L$ and $L_s < 2 \cdot L$) = 447.1746

From table 10.5, ASCE 41_17: $\text{Eleff} = \text{factor} \cdot E_c \cdot I_g = 1.0893E+014$

factor = 0.30
Ag = 300000.00
Mean concrete strength: $fc' = (fc'_{jacket} \cdot Area_{jacket} + fc'_{core} \cdot Area_{core}) / Area_{section} = 28.23333$
N = 15251.406
 $Ec \cdot Ig = Ec_{jacket} \cdot Ig_{jacket} + Ec_{core} \cdot Ig_{core} = 3.6310E+014$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$
 $y_{ten} = 2.6754055E-006$
with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25 \cdot f_y \cdot (I_b/I_d)^{2/3}) = 296.8915$
d = 707.00
 $y = 0.21520049$
A = 0.00964642
B = 0.00520186
with $p_t = 0.00402142$
 $p_c = 0.00402142$
 $p_v = 0.00142194$
N = 15251.406
b = 400.00
" = 0.06082037
 $y_{comp} = 1.4667378E-005$
with $fc = 33.00$
 $Ec = 26999.444$
 $y = 0.21215815$
A = 0.0093422
B = 0.00502021
with $Es = 200000.00$

Calculation of ratio I_b/I_d

Inadequate Lap Length with $I_b/I_d = 0.30$

End Of Calculation of Shear Capacity for element: column JC1 of floor 1

At local axis: 2

Integration Section: (b)

Calculation No. 14

column C1, Floor 1

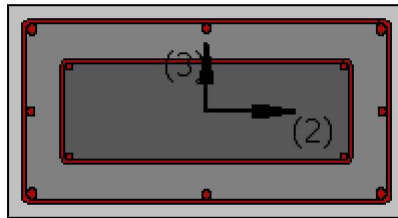
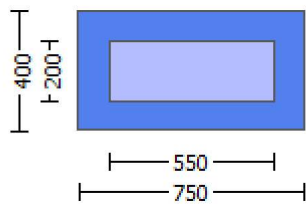
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (ϕ_r)

Edge: End

Local Axis: (2)



Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjrs

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 33.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.56$

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 20.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 444.44$

Concrete Elasticity, $E_c = 21019.039$

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, $f_s = 1.25 \cdot f_{sm} = 694.45$

Existing Column

Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 555.55$

#####

External Height, $H = 400.00$

External Width, $W = 750.00$

Internal Height, $H = 200.00$

Internal Width, $W = 550.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00

Element Length, $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

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

Longitudinal Bars With Ends Lapped Starting at the End Sections

Inadequate Lap Length with $l_o/l_{ou,min} = 0.30$

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = -1.3927229E-031$

EDGE -B-

Shear Force, $V_b = 1.3927229E-031$

BOTH EDGES

Axial Force, $F = -11016.808$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $As_t = 0.00$
 -Compression: $As_c = 2676.637$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten} = 1137.257$
 -Compression: $As_{c,com} = 1137.257$
 -Middle: $As_{mid} = 402.1239$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.19160863$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 115015.186$
 with
 $M_{pr1} = \text{Max}(\mu_{1+}, \mu_{1-}) = 1.7252E+008$
 $\mu_{1+} = 1.7252E+008$, 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
 $\mu_{1-} = 1.7252E+008$, 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
 $M_{pr2} = \text{Max}(\mu_{2+}, \mu_{2-}) = 1.7252E+008$
 $\mu_{2+} = 1.7252E+008$, 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
 $\mu_{2-} = 1.7252E+008$, 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

Calculation of μ_{1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 1.7214953E-005$
 $\mu_u = 1.7252E+008$

with full section properties:

$b = 750.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.00124684$
 $N = 11016.808$
 $f_c = 33.00$
 $\phi_{co} (5A.5, \text{TB DY}) = 0.002$
 Final value of ϕ_u : $\phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_{co}) = 0.0052143$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TB DY: $\phi_u = 0.0052143$
 $\phi_{we} (5.4c) = 0.00183676$
 $\phi_{ase} ((5.4d), \text{TB DY}) = (\phi_{ase1} * A_{ext} + \phi_{ase2} * A_{int}) / A_{sec} = 0.12601038$
 $\phi_{ase1} = 0.12601038$
 $b_{o_1} = 690.00$
 $h_{o_1} = 340.00$
 $b_{i2_1} = 1.1834E+006$
 $\phi_{ase2} = \text{Max}(\phi_{ase1}, \phi_{ase2}) = 0.12601038$
 $b_{o_2} = 542.00$
 $h_{o_2} = 192.00$
 $b_{i2_2} = 661256.00$
 $\phi_{psh,min} * F_{ywe} = \text{Min}(\phi_{psh,x} * F_{ywe}, \phi_{psh,y} * F_{ywe}) = 1.60339$
 Expression ((5.4d), TB DY) 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)

$\phi_{psh,x} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{psh2} * F_{ywe2} = 1.60339$
 $\phi_{ps1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.0020944$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h_1 = 400.00$
 $\phi_{ps2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00026808$

Ash2 = Astir_2*ns_2 = 100.531
 No stirups, ns_2 = 2.00
 h2 = 200.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.13667
 ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
 Ash1 = Astir_1*ns_1 = 157.0796
 No stirups, ns_1 = 2.00
 h1 = 750.00
 ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
 Ash2 = Astir_2*ns_2 = 100.531
 No stirups, ns_2 = 2.00
 h2 = 550.00

Asec = 300000.00

s1 = 100.00

s2 = 250.00

fywe1 = 694.45

fywe2 = 555.55

fce = 33.00

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

c = confinement factor = 1.00

y1 = 0.00140044

sh1 = 0.0044814

ft1 = 441.5397

fy1 = 367.9498

su1 = 0.00512

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

lo/lou,min = lb/lb = 0.30

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

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

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

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

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 367.9498

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

y2 = 0.00140044

sh2 = 0.0044814

ft2 = 441.5397

fy2 = 367.9498

su2 = 0.00512

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

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

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

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

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

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

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 367.9498

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

yv = 0.00140044

shv = 0.0044814

ftv = 466.8167

fyv = 389.0139

suv = 0.00512

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

lo/lou,min = lb/lb = 0.30

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

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

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

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

characteristic value $f_{sv} = f_{sv}/1.2$, 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 $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 389.0139$

with $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.04735912$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.04735912$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.01770442$

and confined core properties:

$b = 690.00$

$d = 327.00$

$d' = 13.00$

$f_{cc} \text{ (5A.2, TBDY)} = 33.00$

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

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

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.05619999$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.05619999$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.02100943$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$su \text{ (4.9)} = 0.16690234$

$Mu = MR_c \text{ (4.14)} = 1.7252E+008$

$u = su \text{ (4.1)} = 1.7214953E-005$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of $Mu1$ -

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

$u = 1.7214953E-005$

$Mu = 1.7252E+008$

with full section properties:

$b = 750.00$

$d = 357.00$

$d' = 43.00$

$v = 0.00124684$

$N = 11016.808$

$f_c = 33.00$

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

Final value of cu : $cu^* = \text{shear_factor} \cdot \text{Max}(cu, cc) = 0.0052143$

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

From (5.4b), TBDY: $cu = 0.0052143$

we (5.4c) = 0.00183676

$ase \text{ ((5.4d), TBDY)} = (ase1 \cdot A_{ext} + ase2 \cdot A_{int}) / A_{sec} = 0.12601038$

$ase1 = 0.12601038$

$bo_1 = 690.00$

$ho_1 = 340.00$

$bi2_1 = 1.1834E+006$

$ase2 = \text{Max}(ase1, ase2) = 0.12601038$

$bo_2 = 542.00$

$ho_2 = 192.00$

$bi2_2 = 661256.00$

$psh_{min} \cdot F_{ywe} = \text{Min}(psh_x \cdot F_{ywe}, psh_y \cdot F_{ywe}) = 1.60339$

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)

$psh_x \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 1.60339$

$$ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.0020944$$

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

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

$$h1 = 400.00$$

$$ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00026808$$

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

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

$$h2 = 200.00$$

$$psh_y \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 3.13667$$

$$ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00392699$$

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

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

$$h1 = 750.00$$

$$ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00073723$$

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

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

$$h2 = 550.00$$

$$Asec = 300000.00$$

$$s1 = 100.00$$

$$s2 = 250.00$$

$$fywe1 = 694.45$$

$$fywe2 = 555.55$$

$$fce = 33.00$$

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

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

$$y1 = 0.00140044$$

$$sh1 = 0.0044814$$

$$ft1 = 441.5397$$

$$fy1 = 367.9498$$

$$su1 = 0.00512$$

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

$$lo/lou, \min = lb/ld = 0.30$$

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

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

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

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

$$\text{with } fs1 = (fs_{\text{jacket}} \cdot Asl, \text{ten, jacket} + fs_{\text{core}} \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 367.9498$$

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

$$y2 = 0.00140044$$

$$sh2 = 0.0044814$$

$$ft2 = 441.5397$$

$$fy2 = 367.9498$$

$$su2 = 0.00512$$

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

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

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

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

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

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

$$\text{with } fs2 = (fs_{\text{jacket}} \cdot Asl, \text{com, jacket} + fs_{\text{core}} \cdot Asl, \text{com, core}) / Asl, \text{com} = 367.9498$$

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

$$yv = 0.00140044$$

$$shv = 0.0044814$$

$$ftv = 466.8167$$

$$fyv = 389.0139$$

$$suv = 0.00512$$

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

$l_o/l_{ou,min} = l_b/l_d = 0.30$
 $suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv , shv , ftv , fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1$, $sh1$, $ft1$, $fy1$, are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs_jacket * Asl_mid,jacket + fs_mid * Asl_mid,core) / Asl_mid = 389.0139$
 with $Esv = (Es_jacket * Asl_mid,jacket + Es_mid * Asl_mid,core) / Asl_mid = 200000.00$
 $1 = Asl_ten / (b * d) * (fs1 / fc) = 0.04735912$
 $2 = Asl_com / (b * d) * (fs2 / fc) = 0.04735912$
 $v = Asl_mid / (b * d) * (fsv / fc) = 0.01770442$
 and confined core properties:
 $b = 690.00$
 $d = 327.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl_ten / (b * d) * (fs1 / fc) = 0.05619999$
 $2 = Asl_com / (b * d) * (fs2 / fc) = 0.05619999$
 $v = Asl_mid / (b * d) * (fsv / fc) = 0.02100943$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < vs,y2$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.16690234$
 $Mu = MRc (4.14) = 1.7252E+008$
 $u = su (4.1) = 1.7214953E-005$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of $Mu2+$

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

$u = 1.7214953E-005$
 $Mu = 1.7252E+008$

with full section properties:

$b = 750.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.00124684$
 $N = 11016.808$
 $fc = 33.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0052143$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.0052143$
 $we (5.4c) = 0.00183676$
 $ase ((5.4d), TBDY) = (ase1 * Aext + ase2 * Aint) / Asec = 0.12601038$
 $ase1 = 0.12601038$
 $bo_1 = 690.00$
 $ho_1 = 340.00$
 $bi2_1 = 1.1834E+006$
 $ase2 = \text{Max}(ase1, ase2) = 0.12601038$
 $bo_2 = 542.00$
 $ho_2 = 192.00$
 $bi2_2 = 661256.00$

$psh,min*Fywe = \text{Min}(psh,x*Fywe, psh,y*Fywe) = 1.60339$
 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)

$psh_x*Fywe = psh1*Fywe1 + ps2*Fywe2 = 1.60339$
 $ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.0020944$
 $Ash1 = Astir_1*ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00026808$
 $Ash2 = Astir_2*ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

$psh_y*Fywe = psh1*Fywe1 + ps2*Fywe2 = 3.13667$
 $ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00392699$
 $Ash1 = Astir_1*ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 750.00$
 $ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00073723$
 $Ash2 = Astir_2*ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 550.00$

$Asec = 300000.00$
 $s1 = 100.00$
 $s2 = 250.00$
 $fywe1 = 694.45$
 $fywe2 = 555.55$
 $fce = 33.00$

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

$y1 = 0.00140044$
 $sh1 = 0.0044814$
 $ft1 = 441.5397$
 $fy1 = 367.9498$
 $su1 = 0.00512$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/ld = 0.30$

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

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 $fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 367.9498$

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

$y2 = 0.00140044$
 $sh2 = 0.0044814$
 $ft2 = 441.5397$
 $fy2 = 367.9498$
 $su2 = 0.00512$

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

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

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

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 $fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 367.9498$

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

$yv = 0.00140044$
 $shv = 0.0044814$
 $ftv = 466.8167$

```

fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lo,min = lb/ld = 0.30
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fsjacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04735912
2 = Asl,com/(b*d)*(fs2/fc) = 0.04735912
v = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05619999
2 = Asl,com/(b*d)*(fs2/fc) = 0.05619999
v = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.16690234
Mu = MRc (4.14) = 1.7252E+008
u = su (4.1) = 1.7214953E-005

```

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

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

```

u = 1.7214953E-005
Mu = 1.7252E+008

```

with full section properties:

```

b = 750.00
d = 357.00
d' = 43.00
v = 0.00124684
N = 11016.808
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.0052143
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0052143
we (5.4c) = 0.00183676
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00

```


$bi2_1 = 1.1834E+006$
 $ase2 = \text{Max}(ase1, ase2) = 0.12601038$
 $bo_2 = 542.00$
 $ho_2 = 192.00$
 $bi2_2 = 661256.00$
 $psh, \min * Fywe = \text{Min}(psh, x * Fywe, psh, y * Fywe) = 1.60339$
 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)

$psh_x * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 1.60339$
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.0020944$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00026808$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

$psh_y * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 3.13667$
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.00392699$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 750.00$
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00073723$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 550.00$

$Asec = 300000.00$
 $s1 = 100.00$
 $s2 = 250.00$
 $fywe1 = 694.45$
 $fywe2 = 555.55$
 $fce = 33.00$

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

$y1 = 0.00140044$
 $sh1 = 0.0044814$
 $ft1 = 441.5397$
 $fy1 = 367.9498$
 $su1 = 0.00512$

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

$lo/lou, \min = lb/ld = 0.30$

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

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 $fs1 = (fs, \text{jacket} * Asl, \text{ten, jacket} + fs, \text{core} * Asl, \text{ten, core}) / Asl, \text{ten} = 367.9498$

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

$y2 = 0.00140044$
 $sh2 = 0.0044814$
 $ft2 = 441.5397$
 $fy2 = 367.9498$
 $su2 = 0.00512$

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

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

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

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.

$$\text{with } fs_2 = (fs_{\text{jacket}} \cdot Asl_{\text{com,jacket}} + fs_{\text{core}} \cdot Asl_{\text{com,core}}) / Asl_{\text{com}} = 367.9498$$

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

$$yv = 0.00140044$$

$$shv = 0.0044814$$

$$ftv = 466.8167$$

$$fyv = 389.0139$$

$$suv = 0.00512$$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

$$lo/lou, \min = lb/ld = 0.30$$

$$suv = 0.4 \cdot esuv_{\text{nominal}} ((5.5), \text{TBDY}) = 0.032$$
 From table 5A.1, TBDY: $esuv_{\text{nominal}} = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{\text{nominal}}$ and yv, shv, 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.

$$\text{with } fsv = (fs_{\text{jacket}} \cdot Asl_{\text{mid,jacket}} + fs_{\text{mid}} \cdot Asl_{\text{mid,core}}) / Asl_{\text{mid}} = 389.0139$$

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

$$1 = Asl_{\text{ten}} / (b \cdot d) \cdot (fs_1 / fc) = 0.04735912$$

$$2 = Asl_{\text{com}} / (b \cdot d) \cdot (fs_2 / fc) = 0.04735912$$

$$v = Asl_{\text{mid}} / (b \cdot d) \cdot (fsv / fc) = 0.01770442$$

and confined core properties:

$$b = 690.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$fcc (5A.2, \text{TBDY}) = 33.00$$

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

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

$$1 = Asl_{\text{ten}} / (b \cdot d) \cdot (fs_1 / fc) = 0.05619999$$

$$2 = Asl_{\text{com}} / (b \cdot d) \cdot (fs_2 / fc) = 0.05619999$$

$$v = Asl_{\text{mid}} / (b \cdot d) \cdot (fsv / fc) = 0.02100943$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$$su (4.9) = 0.16690234$$

$$Mu = MRc (4.14) = 1.7252E+008$$

$$u = su (4.1) = 1.7214953E-005$$

Calculation of ratio lb/ld

Inadequate Lap Length with $lb/ld = 0.30$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 600261.003$

Calculation of Shear Strength at edge 1, $V_{r1} = 600261.003$

$V_{r1} = V_{Co1} ((10.3), \text{ASCE 41-17}) = knl \cdot V_{Co10}$

$V_{Co10} = 600261.003$

$knl = 1$ (zero step-static loading)

NOTE: In expression (10-3) ' $V_s = A_v \cdot f_y \cdot d / s$ ' is replaced by ' $V_{s+} = f \cdot V_f$ '
 where V_f is the contribution of FRPs (11.3), ACI 440).

= 1 (normal-weight concrete)

Mean concrete strength: $fc' = (fc'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + fc'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 28.23333$, but $fc'^{0.5} \leq 8.3 \text{ MPa}$ (22.5.3.1, ACI 318-14)

$M/Vd = 2.00$

$Mu = 1.0002017E-011$

$Vu = 1.3927229E-031$

$d = 0.8 \cdot h = 320.00$

$Nu = 11016.808$

$A_g = 300000.00$
 From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} = 279254.914$
 where:
 $V_{s1} = 279254.914$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 555.56$
 $s = 100.00$
 V_{s1} is multiplied by $Col1 = 1.00$
 $s/d = 0.3125$
 $V_{s2} = 0.00$ is calculated for core, with:
 $d = 160.00$
 $A_v = 100530.965$
 $f_y = 444.44$
 $s = 250.00$
 V_{s2} is multiplied by $Col2 = 0.00$
 $s/d = 1.5625$
 $V_f ((11-3)-(11.4), ACI 440) = 0.00$
 From (11-11), ACI 440: $V_s + V_f \leq 847147.582$
 $bw = 750.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 600261.003$
 $V_{r2} = V_{Col} ((10.3), ASCE 41-17) = knl * V_{Col0}$
 $V_{Col0} = 600261.003$
 $knl = 1$ (zero step-static loading)

NOTE: In expression (10-3) ' $V_s = A_v * f_y * d / s$ ' is replaced by ' $V_s + f * V_f$ '
 where V_f is the contribution of FRPs (11.3), ACI 440).

$= 1$ (normal-weight concrete)
 Mean concrete strength: $f_c' = (f_c'_{jacket} * Area_{jacket} + f_c'_{core} * Area_{core}) / Area_{section} = 28.23333$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $M/Vd = 2.00$
 $M_u = 1.0002017E-011$
 $V_u = 1.3927229E-031$
 $d = 0.8 * h = 320.00$
 $N_u = 11016.808$
 $A_g = 300000.00$
 From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} = 279254.914$
 where:
 $V_{s1} = 279254.914$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 555.56$
 $s = 100.00$
 V_{s1} is multiplied by $Col1 = 1.00$
 $s/d = 0.3125$
 $V_{s2} = 0.00$ is calculated for core, with:
 $d = 160.00$
 $A_v = 100530.965$
 $f_y = 444.44$
 $s = 250.00$
 V_{s2} is multiplied by $Col2 = 0.00$
 $s/d = 1.5625$
 $V_f ((11-3)-(11.4), ACI 440) = 0.00$
 From (11-11), ACI 440: $V_s + V_f \leq 847147.582$
 $bw = 750.00$

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

Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1

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

Constant Properties

Knowledge Factor, $\phi = 1.00$
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.56$
Concrete Elasticity, $E_c = 26999.444$
Steel Elasticity, $E_s = 200000.00$
Existing Column
Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 20.00$
Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 444.44$
Concrete Elasticity, $E_c = 21019.039$
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, $f_s = 1.25 \cdot f_{sm} = 694.45$
Existing Column
Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 555.55$

External Height, $H = 400.00$
External Width, $W = 750.00$
Internal Height, $H = 200.00$
Internal Width, $W = 550.00$
Cover Thickness, $c = 25.00$
Mean Confinement Factor overall section = 1.00
Element Length, $L = 3000.00$
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with $l_o/l_{ou,min} = 0.30$
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, $V_a = -3.9443045E-031$
EDGE -B-
Shear Force, $V_b = 3.9443045E-031$
BOTH EDGES
Axial Force, $F = -11016.808$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $As_t = 0.00$
-Compression: $As_c = 2676.637$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $As_{t,ten} = 1137.257$
-Compression: $As_{l,com} = 1137.257$
-Middle: $As_{l,mid} = 402.1239$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.25537128$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 235770.47$
with

$$M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 3.5366E+008$$

$M_{u1+} = 3.5366E+008$, 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

$M_{u1-} = 3.5366E+008$, 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

$$M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 3.5366E+008$$

$M_{u2+} = 3.5366E+008$, 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

$M_{u2-} = 3.5366E+008$, 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

Calculation of M_{u1+}

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

$$\phi_u = 8.5738376E-006$$

$$M_u = 3.5366E+008$$

with full section properties:

$$b = 400.00$$

$$d = 707.00$$

$$d' = 43.00$$

$$v = 0.00118049$$

$$N = 11016.808$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.0052143$$

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

$$\text{From (5.4b), TB DY: } \phi_u = 0.0052143$$

$$w_e(5.4c) = 0.00183676$$

$$a_{se}((5.4d), \text{TB DY}) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.12601038$$

$$a_{se1} = 0.12601038$$

$$b_{o_1} = 690.00$$

$$h_{o_1} = 340.00$$

$$b_{i2_1} = 1.1834E+006$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.12601038$$

$$b_{o_2} = 542.00$$

$$h_{o_2} = 192.00$$

$$b_{i2_2} = 661256.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.60339$$

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)

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.60339$$

$$p_{sh1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.0020944$$

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

No stirrups, $n_{s_1} = 2.00$

$$h_1 = 400.00$$

$$p_{sh2}(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00026808$$

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

No stirrups, $n_{s_2} = 2.00$

$$h_2 = 200.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 3.13667$$

$$p_{sh1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00392699$$

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

No stirrups, $n_{s_1} = 2.00$

$$h_1 = 750.00$$

$$p_{sh2}(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00073723$$

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

No stirrups, $n_{s_2} = 2.00$

$$h_2 = 550.00$$

$$A_{sec} = 300000.00$$

$$s_1 = 100.00$$

$s_2 = 250.00$
 $fy_{w1} = 694.45$
 $fy_{w2} = 555.55$
 $f_{ce} = 33.00$
 From ((5A.5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$
 $y_1 = 0.00140044$
 $sh_1 = 0.0044814$
 $ft_1 = 441.5397$
 $fy_1 = 367.9498$
 $su_1 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou, \min = lb/ld = 0.30$
 $su_1 = 0.4 * esu_1 \text{ nominal } ((5.5), \text{TBDY}) = 0.032$
 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 $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_1 = (fs_{\text{jacket}} * A_{sl, \text{ten, jacket}} + fs_{\text{core}} * A_{sl, \text{ten, core}}) / A_{sl, \text{ten}} = 367.9498$
 with $Es_1 = (Es_{\text{jacket}} * A_{sl, \text{ten, jacket}} + Es_{\text{core}} * A_{sl, \text{ten, core}}) / A_{sl, \text{ten}} = 200000.00$
 $y_2 = 0.00140044$
 $sh_2 = 0.0044814$
 $ft_2 = 441.5397$
 $fy_2 = 367.9498$
 $su_2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou, \min = lb/lb, \min = 0.30$
 $su_2 = 0.4 * esu_2 \text{ nominal } ((5.5), \text{TBDY}) = 0.032$
 From table 5A.1, TBDY: $esu_2 \text{ nominal} = 0.08$,
 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, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = (fs_{\text{jacket}} * A_{sl, \text{com, jacket}} + fs_{\text{core}} * A_{sl, \text{com, core}}) / A_{sl, \text{com}} = 367.9498$
 with $Es_2 = (Es_{\text{jacket}} * A_{sl, \text{com, jacket}} + Es_{\text{core}} * A_{sl, \text{com, core}}) / A_{sl, \text{com}} = 200000.00$
 $y_v = 0.00140044$
 $sh_v = 0.0044814$
 $ft_v = 466.8167$
 $fy_v = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou, \min = lb/ld = 0.30$
 $suv = 0.4 * esuv \text{ nominal } ((5.5), \text{TBDY}) = 0.032$
 From table 5A.1, TBDY: $esuv \text{ nominal} = 0.08$,
 considering characteristic value $fsyv = fs_v/1.2$, from table 5.1, TBDY
 For calculation of $esuv \text{ nominal}$ 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 $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_v = (fs_{\text{jacket}} * A_{sl, \text{mid, jacket}} + fs_{\text{mid}} * A_{sl, \text{mid, core}}) / A_{sl, \text{mid}} = 389.0139$
 with $Es_v = (Es_{\text{jacket}} * A_{sl, \text{mid, jacket}} + Es_{\text{mid}} * A_{sl, \text{mid, core}}) / A_{sl, \text{mid}} = 200000.00$
 $1 = A_{sl, \text{ten}} / (b * d) * (fs_1 / f_c) = 0.04483877$
 $2 = A_{sl, \text{com}} / (b * d) * (fs_2 / f_c) = 0.04483877$
 $v = A_{sl, \text{mid}} / (b * d) * (fs_v / f_c) = 0.01676222$
 and confined core properties:
 $b = 340.00$
 $d = 677.00$
 $d' = 13.00$
 $f_{cc} (5A.2, \text{TBDY}) = 33.00$
 $cc (5A.5, \text{TBDY}) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl, \text{ten}} / (b * d) * (fs_1 / f_c) = 0.05508907$
 $2 = A_{sl, \text{com}} / (b * d) * (fs_2 / f_c) = 0.05508907$

$v = A_{sl, mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.02059413$
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)

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

--->
 $\mu_u (4.9) = 0.1553529$
 $\mu_u = M_{Rc} (4.14) = 3.5366E+008$
 $u = \mu_u (4.1) = 8.5738376E-006$

Calculation of ratio I_b/I_d

Inadequate Lap Length with $I_b/I_d = 0.30$

Calculation of μ_{u1} -

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

$u = 8.5738376E-006$
 $\mu_u = 3.5366E+008$

with full section properties:

$b = 400.00$
 $d = 707.00$
 $d' = 43.00$
 $v = 0.00118049$
 $N = 11016.808$
 $f_c = 33.00$
 $\alpha (5A.5, TBDY) = 0.002$
Final value of μ_u : $\mu_u^* = \text{shear_factor} \cdot \text{Max}(\mu_u, \mu_c) = 0.0052143$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $\mu_u = 0.0052143$
 $\mu_w (5.4c) = 0.00183676$
 $\alpha_{se} ((5.4d), TBDY) = (\alpha_{se1} \cdot A_{ext} + \alpha_{se2} \cdot A_{int}) / A_{sec} = 0.12601038$
 $\alpha_{se1} = 0.12601038$
 $b_{o_1} = 690.00$
 $h_{o_1} = 340.00$
 $b_{i2_1} = 1.1834E+006$
 $\alpha_{se2} = \text{Max}(\alpha_{se1}, \alpha_{se2}) = 0.12601038$
 $b_{o_2} = 542.00$
 $h_{o_2} = 192.00$
 $b_{i2_2} = 661256.00$
 $\mu_{sh, min} \cdot F_{ywe} = \text{Min}(\mu_{sh, x} \cdot F_{ywe}, \mu_{sh, y} \cdot F_{ywe}) = 1.60339$

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

$\mu_{sh, x} \cdot F_{ywe} = \mu_{sh1} \cdot F_{ywe1} + \mu_{sh2} \cdot F_{ywe2} = 1.60339$
 $\mu_{sh1} \text{ (external)} = (A_{sh1} \cdot h_1 / s_1) / A_{sec} = 0.0020944$
 $A_{sh1} = A_{stir_1} \cdot n_{s_1} = 157.0796$
No stirrups, $n_{s_1} = 2.00$
 $h_1 = 400.00$
 $\mu_{sh2} \text{ (internal)} = (A_{sh2} \cdot h_2 / s_2) / A_{sec} = 0.00026808$
 $A_{sh2} = A_{stir_2} \cdot n_{s_2} = 100.531$
No stirrups, $n_{s_2} = 2.00$
 $h_2 = 200.00$

$\mu_{sh, y} \cdot F_{ywe} = \mu_{sh1} \cdot F_{ywe1} + \mu_{sh2} \cdot F_{ywe2} = 3.13667$
 $\mu_{sh1} \text{ (external)} = (A_{sh1} \cdot h_1 / s_1) / A_{sec} = 0.00392699$
 $A_{sh1} = A_{stir_1} \cdot n_{s_1} = 157.0796$
No stirrups, $n_{s_1} = 2.00$
 $h_1 = 750.00$
 $\mu_{sh2} \text{ (internal)} = (A_{sh2} \cdot h_2 / s_2) / A_{sec} = 0.00073723$
 $A_{sh2} = A_{stir_2} \cdot n_{s_2} = 100.531$

No stirrups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00

s1 = 100.00

s2 = 250.00

fywe1 = 694.45

fywe2 = 555.55

fce = 33.00

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

c = confinement factor = 1.00

y1 = 0.00140044

sh1 = 0.0044814

ft1 = 441.5397

fy1 = 367.9498

su1 = 0.00512

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

lo/lou,min = lb/lb = 0.30

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

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

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

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

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 367.9498

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

y2 = 0.00140044

sh2 = 0.0044814

ft2 = 441.5397

fy2 = 367.9498

su2 = 0.00512

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

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

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

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

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

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

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 367.9498

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

yv = 0.00140044

shv = 0.0044814

ftv = 466.8167

fyv = 389.0139

suv = 0.00512

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

lo/lou,min = lb/lb = 0.30

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

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

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

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

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

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

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

1 = Asl,ten/(b*d)*(fs1/fc) = 0.04483877

2 = Asl,com/(b*d)*(fs2/fc) = 0.04483877

v = Asl,mid/(b*d)*(fsv/fc) = 0.01676222

and confined core properties:

b = 340.00

d = 677.00

d' = 13.00


```

fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05508907
2 = Asl,com/(b*d)*(fs2/fc) = 0.05508907
v = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.1553529
Mu = MRc (4.14) = 3.5366E+008
u = su (4.1) = 8.5738376E-006

```

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

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

u = 8.5738376E-006

Mu = 3.5366E+008

with full section properties:

b = 400.00

d = 707.00

d' = 43.00

v = 0.00118049

N = 11016.808

fc = 33.00

co (5A.5, TBDY) = 0.002

Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0052143

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

From (5.4b), TBDY: cu = 0.0052143

we (5.4c) = 0.00183676

ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.12601038

ase1 = 0.12601038

bo_1 = 690.00

ho_1 = 340.00

bi2_1 = 1.1834E+006

ase2 = Max(ase1,ase2) = 0.12601038

bo_2 = 542.00

ho_2 = 192.00

bi2_2 = 661256.00

psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.60339

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 = 1.60339

ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944

Ash1 = Astir_1*ns_1 = 157.0796

No stirrups, ns_1 = 2.00

h1 = 400.00

ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808

Ash2 = Astir_2*ns_2 = 100.531

No stirrups, ns_2 = 2.00

h2 = 200.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.13667

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

$Ash1 = Astir_1 * ns_1 = 157.0796$
 $No\ stirups, ns_1 = 2.00$
 $h1 = 750.00$
 $ps2\ (internal) = (Ash2 * h2 / s2) / Asec = 0.00073723$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 $No\ stirups, ns_2 = 2.00$
 $h2 = 550.00$

$Asec = 300000.00$
 $s1 = 100.00$
 $s2 = 250.00$
 $fywe1 = 694.45$
 $fywe2 = 555.55$
 $fce = 33.00$

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

$y1 = 0.00140044$
 $sh1 = 0.0044814$
 $ft1 = 441.5397$
 $fy1 = 367.9498$
 $su1 = 0.00512$

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

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

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

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

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

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

with $fs1 = (fs,jacket * Asl,ten,jacket + fs,core * Asl,ten,core) / Asl,ten = 367.9498$

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

$y2 = 0.00140044$
 $sh2 = 0.0044814$

$ft2 = 441.5397$
 $fy2 = 367.9498$

$su2 = 0.00512$

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

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

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

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

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

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

with $fs2 = (fs,jacket * Asl,com,jacket + fs,core * Asl,com,core) / Asl,com = 367.9498$

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

$yv = 0.00140044$
 $shv = 0.0044814$

$ftv = 466.8167$
 $fyv = 389.0139$

$suv = 0.00512$

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

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

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

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

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

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

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

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

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

$1 = Asl,ten / (b * d) * (fs1 / fc) = 0.04483877$

$2 = Asl,com / (b * d) * (fs2 / fc) = 0.04483877$

```

v = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05508907
2 = Asl,com/(b*d)*(fs2/fc) = 0.05508907
v = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.1553529
Mu = MRc (4.14) = 3.5366E+008
u = su (4.1) = 8.5738376E-006

```

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 8.5738376E-006
Mu = 3.5366E+008

with full section properties:

```

b = 400.00
d = 707.00
d' = 43.00
v = 0.00118049
N = 11016.808
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.0052143
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0052143
we (5.4c) = 0.00183676
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
bi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
bi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.60339
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 = 1.60339
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531

```

No stirups, ns_2 = 2.00
h2 = 200.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.13667
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00

s1 = 100.00

s2 = 250.00

fywe1 = 694.45

fywe2 = 555.55

fce = 33.00

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

c = confinement factor = 1.00

y1 = 0.00140044

sh1 = 0.0044814

ft1 = 441.5397

fy1 = 367.9498

su1 = 0.00512

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

lo/lou,min = lb/ld = 0.30

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

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

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

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

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 367.9498

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

y2 = 0.00140044

sh2 = 0.0044814

ft2 = 441.5397

fy2 = 367.9498

su2 = 0.00512

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

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

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

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

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

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

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 367.9498

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

yv = 0.00140044

shv = 0.0044814

ftv = 466.8167

fyv = 389.0139

suv = 0.00512

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

lo/lou,min = lb/ld = 0.30

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

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

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

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs_{jacket} \cdot Asl_{mid,jacket} + fs_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 389.0139$
 with $Es_v = (Es_{jacket} \cdot Asl_{mid,jacket} + Es_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 200000.00$
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.04483877$
 $2 = Asl_{com} / (b \cdot d) \cdot (fs2 / fc) = 0.04483877$
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.01676222$

and confined core properties:

$b = 340.00$
 $d = 677.00$
 $d' = 13.00$
 fcc (5A.2, TBDY) = 33.00
 cc (5A.5, TBDY) = 0.002
 c = confinement factor = 1.00
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.05508907$
 $2 = Asl_{com} / (b \cdot d) \cdot (fs2 / fc) = 0.05508907$
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.02059413$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

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

su (4.9) = 0.1553529

$Mu = MRc$ (4.14) = 3.5366E+008

$u = su$ (4.1) = 8.5738376E-006

Calculation of ratio lb/ld

Inadequate Lap Length with $lb/ld = 0.30$

Calculation of Shear Strength $Vr = \text{Min}(Vr1, Vr2) = 923245.821$

Calculation of Shear Strength at edge 1, $Vr1 = 923245.821$

$Vr1 = VCol$ ((10.3), ASCE 41-17) = $knl \cdot VCol0$

$VCol0 = 923245.821$

$knl = 1$ (zero step-static loading)

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

= 1 (normal-weight concrete)

Mean concrete strength: $fc' = (fc'_{jacket} \cdot Area_{jacket} + fc'_{core} \cdot Area_{core}) / Area_{section} = 28.23333$, but $fc'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$M/Vd = 2.00$

$Mu = 6.8236829E-012$

$Vu = 3.9443045E-031$

$d = 0.8 \cdot h = 600.00$

$Nu = 11016.808$

$Ag = 300000.00$

From (11.5.4.8), ACI 318-14: $Vs = Vs1 + Vs2 = 602239.733$

where:

$Vs1 = 523602.964$ is calculated for jacket, with:

$d = 600.00$

$Av = 157079.633$

$fy = 555.56$

$s = 100.00$

$Vs1$ is multiplied by $Col1 = 1.00$

$s/d = 0.16666667$

$Vs2 = 78636.768$ is calculated for core, with:

$d = 440.00$

$Av = 100530.965$

$fy = 444.44$

$s = 250.00$

$Vs2$ is multiplied by $Col2 = 1.00$

s/d = 0.56818182
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 847147.582
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 923245.821
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 923245.821
knl = 1 (zero step-static loading)

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

= 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 28.23333, but fc'^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 6.8236829E-012
Vu = 3.9443045E-031
d = 0.8*h = 600.00
Nu = 11016.808
Ag = 300000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 602239.733
where:
Vs1 = 523602.964 is calculated for jacket, with:
d = 600.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by Col1 = 1.00
s/d = 0.16666667
Vs2 = 78636.768 is calculated for core, with:
d = 440.00
Av = 100530.965
fy = 444.44
s = 250.00
Vs2 is multiplied by Col2 = 1.00
s/d = 0.56818182
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 847147.582
bw = 400.00

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

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

Constant Properties

Knowledge Factor, = 1.00
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 20.00$
 Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 444.44$
 Concrete Elasticity, $E_c = 21019.039$
 Steel Elasticity, $E_s = 200000.00$
 External Height, $H = 400.00$
 External Width, $W = 750.00$
 Internal Height, $H = 200.00$
 Internal Width, $W = 550.00$
 Cover Thickness, $c = 25.00$
 Element Length, $L = 3000.00$
 Secondary Member
 Ribbed Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Inadequate Lap Length with $l_b/l_d = 0.30$
 No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 1.6814758E-011$
 Shear Force, $V_2 = 2823.172$
 Shear Force, $V_3 = 3.1363135E-013$
 Axial Force, $F = -15251.406$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $As_t = 0.00$
 -Compression: $As_c = 2676.637$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten} = 1137.257$
 -Compression: $As_{c,com} = 1137.257$
 -Middle: $As_{mid} = 402.1239$
 Longitudinal External Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten,jacket} = 829.3805$
 -Compression: $As_{c,com,jacket} = 829.3805$
 -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: $As_{mid,core} = 0.00$
 Mean Diameter of Tension Reinforcement, $Db_L = 16.80$

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = \phi \cdot u = 0.01790598$
 $u = \phi \cdot y + \phi \cdot p = 0.01790598$

- Calculation of $\phi \cdot y$ -

$y = (M_y \cdot L_s / 3) / E_{eff} = 0.00198111$ ((4.29), Biskinis Phd))
 $M_y = 1.2577E+008$
 $L_s = M/V$ (with $L_s > 0.1 \cdot L$ and $L_s < 2 \cdot L$) = 1500.00
 From table 10.5, ASCE 41_17: $E_{eff} = factor \cdot E_c \cdot I_g = 3.1741E+013$
 $factor = 0.30$
 $A_g = 300000.00$
 Mean concrete strength: $f'_c = (f'_c_{jacket} \cdot Area_{jacket} + f'_c_{core} \cdot Area_{core}) / Area_{section} = 28.23333$
 $N = 15251.406$
 $E_c \cdot I_g = E_{c,jacket} \cdot I_{g,jacket} + E_{c,core} \cdot I_{g,core} = 1.0580E+014$

Calculation of Yielding Moment M_y

Calculation of $\phi \cdot y$ and M_y according to Annex 7 -

```

y = Min( y_ten, y_com)
y_ten = 5.3794571E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^ 2/3) = 296.8915
d = 357.00
y = 0.22703277
A = 0.01018864
B = 0.00579229
with pt = 0.00424746
pc = 0.00424746
pv = 0.00150186
N = 15251.406
b = 750.00
" = 0.12044818
y_comp = 2.7501333E-005
with fc = 33.00
Ec = 26999.444
y = 0.22408338
A = 0.00986732
B = 0.00560044
with Es = 200000.00

```

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

- Calculation of p -

From table 10-8: p = 0.01592487

with:

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

shear control ratio $V_yE/V_{ColOE} = 0.19160863$

d = d_external = 357.00

s = s_external = 0.00

t = s1 + s2 + 2*tf/bw*(ffe/fs) = 0.00236248

jacket: s1 = $A_{v1} \cdot h1 / (s1 \cdot A_g) = 0.0020944$

Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction

h1 = 400.00

s1 = 100.00

core: s2 = $A_{v2} \cdot h2 / (s2 \cdot A_g) = 0.00026808$

Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction

h2 = 200.00

s2 = 250.00

The term $2 \cdot tf/bw \cdot (ffe/fs)$ is implemented to account for FRP contribution

where $f = 2 \cdot tf/bw$ is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises f to steel strength

All these variables have already been given in Shear control ratio calculation.

For the normalisation fs of jacket is used.

NUD = 15251.406

Ag = 300000.00

f_{cE} = $(f_{c_jacket} \cdot Area_jacket + f_{c_core} \cdot Area_core) / section_area = 28.23333$

fy_E = $(f_{y_ext_Long_Reinf} \cdot Area_ext_Long_Reinf + f_{y_int_Long_Reinf} \cdot Area_int_Long_Reinf) / Area_Tot_Long_Rein = 529.9972$

fy_{tE} = $(f_{y_ext_Trans_Reinf} \cdot s1 + f_{y_int_Trans_Reinf} \cdot s2) / (s1 + s2) = 542.9506$

pl = $Area_Tot_Long_Rein / (b \cdot d) = 0.00999678$

b = 750.00

d = 357.00

f_{cE} = 28.23333

End Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1

At local axis: 2

Integration Section: (b)

Calculation No. 15

column C1, Floor 1

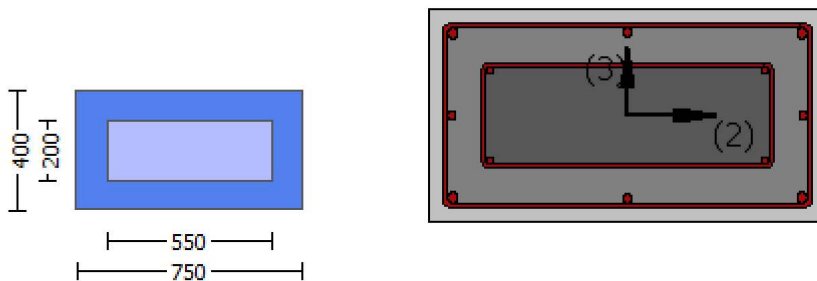
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (3)



Start Of Calculation of Shear Capacity for element: column JC1 of floor 1

At local axis: 3

Integration Section: (b)

Section Type: rcjrs

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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, $f_c = f_{c_lower_bound} = 25.00$

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

Concrete Elasticity, $E_c = 26999.444$

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, $f_s = f_{s_lower_bound} = 400.00$

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of γ for displacement ductility demand, the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as Deformation-Controlled Action (Table C7-1, ASCE 41-17).

Jacket

New material: Concrete Strength, $f_c = f_{cm} = 33.00$

New material: Steel Strength, $f_s = f_{sm} = 555.56$

Existing Column

```

Existing material: Concrete Strength,  $f_c = f_{cm} = 20.00$ 
Existing material: Steel Strength,  $f_s = f_{sm} = 444.44$ 
#####
External Height,  $H = 400.00$ 
External Width,  $W = 750.00$ 
Internal Height,  $H = 200.00$ 
Internal Width,  $W = 550.00$ 
Cover Thickness,  $c = 25.00$ 
Element Length,  $L = 3000.00$ 
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with  $l_o/l_{ou,min} = l_b/l_d = 0.30$ 
No FRP Wrapping
-----

Stepwise Properties
-----
EDGE -A-
Bending Moment,  $M_a = 9.2596107E-010$ 
Shear Force,  $V_a = -3.1363135E-013$ 
EDGE -B-
Bending Moment,  $M_b = 1.6814758E-011$ 
Shear Force,  $V_b = 3.1363135E-013$ 
BOTH EDGES
Axial Force,  $F = -15251.406$ 
Longitudinal Reinforcement Area Distribution (in 2 divisions)
  -Tension:  $A_{st} = 0.00$ 
  -Compression:  $A_{sc} = 2676.637$ 
Longitudinal Reinforcement Area Distribution (in 3 divisions)
  -Tension:  $A_{st,ten} = 1137.257$ 
  -Compression:  $A_{st,com} = 1137.257$ 
  -Middle:  $A_{st,mid} = 402.1239$ 
Mean Diameter of Tension Reinforcement,  $Db_{L,ten} = 16.80$ 
-----
-----

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity  $V_R = V_n = 533860.781$ 
 $V_n$  ((10.3), ASCE 41-17) =  $k_n \cdot V_{CoIO} = 533860.781$ 
 $V_{CoI} = 533860.781$ 
 $k_n = 1.00$ 
displacement_ductility_demand = 0.00
-----

NOTE: In expression (10-3) ' $V_s = A_v \cdot f_y \cdot d / s$ ' is replaced by ' $V_s + f \cdot V_f$ '
where  $V_f$  is the contribution of FRPs ((11.3), ACI 440).
-----

= 1 (normal-weight concrete)
Mean concrete strength:  $f'_c = (f'_{c,jacket} \cdot Area_{jacket} + f'_{c,core} \cdot Area_{core}) / Area_{section} = 21.70$ , but  $f'_c^{0.5} \leq 8.3$ 
MPa ((22.5.3.1, ACI 318-14)
 $M/Vd = 2.00$ 
 $M_u = 1.6814758E-011$ 
 $V_u = 3.1363135E-013$ 
 $d = 0.8 \cdot h = 320.00$ 
 $N_u = 15251.406$ 
 $A_g = 300000.00$ 
From ((11.5.4.8), ACI 318-14:  $V_s = V_{s1} + V_{s2} = 251327.412$ 
where:
 $V_{s1} = 251327.412$  is calculated for jacket, with:
 $d = 320.00$ 
 $A_v = 157079.633$ 
 $f_y = 500.00$ 
 $s = 100.00$ 
 $V_{s1}$  is multiplied by  $Col1 = 1.00$ 
 $s/d = 0.3125$ 

```

Vs2 = 0.00 is calculated for core, with:

$$d = 160.00$$

$$A_v = 100530.965$$

$$f_y = 400.00$$

$$s = 250.00$$

Vs2 is multiplied by Col2 = 0.00

$$s/d = 1.5625$$

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

From (11-11), ACI 440: Vs + Vf <= 742690.493

$$bw = 750.00$$

displacement_ductility_demand is calculated as ϕ / y

- Calculation of ϕ / y for END B -

for rotation axis 2 and integ. section (b)

From analysis, chord rotation $\theta = 4.0359928E-021$

$$y = (M_y * L_s / 3) / E_{eff} = 0.00198111 \text{ ((4.29), Biskinis Phd)}$$

$$M_y = 1.2577E+008$$

$$L_s = M/V \text{ (with } L_s > 0.1 * L \text{ and } L_s < 2 * L) = 1500.00$$

$$\text{From table 10.5, ASCE 41_17: } E_{eff} = \text{factor} * E_c * I_g = 3.1741E+013$$

$$\text{factor} = 0.30$$

$$A_g = 300000.00$$

$$\text{Mean concrete strength: } f_c' = (f_c'_{\text{jacket}} * A_{\text{jacket}} + f_c'_{\text{core}} * A_{\text{core}}) / A_{\text{section}} = 28.23333$$

$$N = 15251.406$$

$$E_c * I_g = E_{c_{\text{jacket}}} * I_{g_{\text{jacket}}} + E_{c_{\text{core}}} * I_{g_{\text{core}}} = 1.0580E+014$$

Calculation of Yielding Moment M_y

Calculation of ϕ and M_y according to Annex 7 -

$$y = \text{Min}(y_{\text{ten}}, y_{\text{com}})$$

$$y_{\text{ten}} = 5.3794571E-006$$

$$\text{with ((10.1), ASCE 41-17) } f_y = \text{Min}(f_y, 1.25 * f_y * (I_b / I_d)^{2/3}) = 296.8915$$

$$d = 357.00$$

$$y = 0.22703277$$

$$A = 0.01018864$$

$$B = 0.00579229$$

$$\text{with } p_t = 0.00424746$$

$$p_c = 0.00424746$$

$$p_v = 0.00150186$$

$$N = 15251.406$$

$$b = 750.00$$

$$\rho = 0.12044818$$

$$y_{\text{comp}} = 2.7501333E-005$$

with $f_c = 33.00$

$$E_c = 26999.444$$

$$y = 0.22408338$$

$$A = 0.00986732$$

$$B = 0.00560044$$

$$\text{with } E_s = 200000.00$$

Calculation of ratio I_b / I_d

Inadequate Lap Length with $I_b / I_d = 0.30$

End Of Calculation of Shear Capacity for element: column JC1 of floor 1

At local axis: 3

Integration Section: (b)

Calculation No. 16

column C1, Floor 1

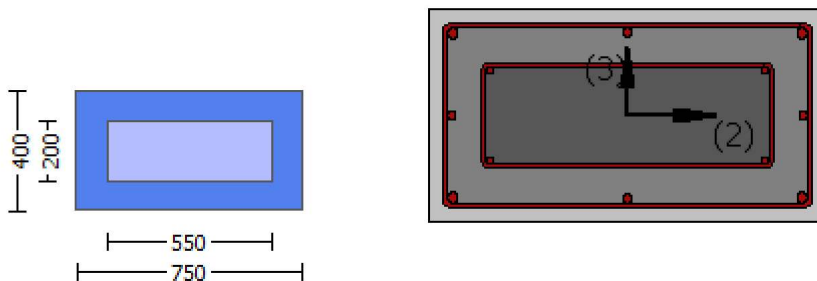
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (μ)

Edge: End

Local Axis: (3)



Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjrs

Constant Properties

Knowledge Factor, $\gamma = 1.00$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 33.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.56$

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Existing Column

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 20.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 444.44$

Concrete Elasticity, $E_c = 21019.039$

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, $f_s = 1.25 \cdot f_{sm} = 694.45$

Existing Column

Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 555.55$

#####

External Height, $H = 400.00$

External Width, $W = 750.00$
 Internal Height, $H = 200.00$
 Internal Width, $W = 550.00$
 Cover Thickness, $c = 25.00$
 Mean Confinement Factor overall section = 1.00
 Element Length, $L = 3000.00$
 Secondary Member
 Ribbed Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Inadequate Lap Length with $l_o/l_{o,min} = 0.30$
 No FRP Wrapping

Stepwise Properties

At local axis: 3
 EDGE -A-
 Shear Force, $V_a = -1.3927229E-031$
 EDGE -B-
 Shear Force, $V_b = 1.3927229E-031$
 BOTH EDGES
 Axial Force, $F = -11016.808$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $As_t = 0.00$
 -Compression: $As_c = 2676.637$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten} = 1137.257$
 -Compression: $As_{c,com} = 1137.257$
 -Middle: $As_{c,mid} = 402.1239$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.19160863$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 115015.186$
 with
 $M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 1.7252E+008$
 $\mu_{u1+} = 1.7252E+008$, 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
 $\mu_{u1-} = 1.7252E+008$, 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
 $M_{pr2} = \max(\mu_{u2+}, \mu_{u2-}) = 1.7252E+008$
 $\mu_{u2+} = 1.7252E+008$, 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
 $\mu_{u2-} = 1.7252E+008$, 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

Calculation of μ_{u1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 1.7214953E-005$
 $\mu_u = 1.7252E+008$

with full section properties:

$b = 750.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.00124684$
 $N = 11016.808$
 $f_c = 33.00$
 ϕ_o (5A.5, TBDY) = 0.002

Final value of cu : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0052143$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $cu = 0.0052143$
we (5.4c) = 0.00183676
ase ((5.4d), TBDY) = $(ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.12601038$
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
bi2_1 = 1.1834E+006
ase2 = $\text{Max}(ase1, ase2) = 0.12601038$
bo_2 = 542.00
ho_2 = 192.00
bi2_2 = 661256.00
psh,min*Fywe = $\text{Min}(psh, x * F_{ywe}, psh, y * F_{ywe}) = 1.60339$
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 = $psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.60339$
ps1 (external) = $(A_{sh1} * h1 / s1) / A_{sec} = 0.0020944$
Ash1 = Astir_1*ns_1 = 157.0796
No stirrups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = $(A_{sh2} * h2 / s2) / A_{sec} = 0.00026808$
Ash2 = Astir_2*ns_2 = 100.531
No stirrups, ns_2 = 2.00
h2 = 200.00

psh_y*Fywe = $psh1 * F_{ywe1} + ps2 * F_{ywe2} = 3.13667$
ps1 (external) = $(A_{sh1} * h1 / s1) / A_{sec} = 0.00392699$
Ash1 = Astir_1*ns_1 = 157.0796
No stirrups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = $(A_{sh2} * h2 / s2) / A_{sec} = 0.00073723$
Ash2 = Astir_2*ns_2 = 100.531
No stirrups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 555.55
fce = 33.00

From ((5.A5), TBDY), TBDY: $cc = 0.002$
c = confinement factor = 1.00

y1 = 0.00140044
sh1 = 0.0044814
ft1 = 441.5397
fy1 = 367.9498
su1 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = $l_b / l_d = 0.30$

su1 = $0.4 * esu1_nominal$ ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: $esu1_nominal = 0.08$,

For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
characteristic value $fsy1 = fs1 / 1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (l_b / l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs1 = (f_{s,jacket} * A_{s,ten,jacket} + f_{s,core} * A_{s,ten,core}) / A_{s,ten} = 367.9498$

with $Es1 = (E_{s,jacket} * A_{s,ten,jacket} + E_{s,core} * A_{s,ten,core}) / A_{s,ten} = 200000.00$

y2 = 0.00140044
sh2 = 0.0044814
ft2 = 441.5397
fy2 = 367.9498
su2 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.30$
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$
 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 $fs_2 = (fs_{jacket} * Asl_{com,jacket} + fs_{core} * Asl_{com,core}) / Asl_{com} = 367.9498$
 with $Es_2 = (Es_{jacket} * Asl_{com,jacket} + Es_{core} * Asl_{com,core}) / Asl_{com} = 200000.00$
 $y_v = 0.00140044$
 $sh_v = 0.0044814$
 $ft_v = 466.8167$
 $fy_v = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.30$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsv = fs_v/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fsv = fs_v/1.2$, 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 $fs_v = (fs_{jacket} * Asl_{mid,jacket} + fs_{mid} * Asl_{mid,core}) / Asl_{mid} = 389.0139$
 with $Es_v = (Es_{jacket} * Asl_{mid,jacket} + Es_{mid} * Asl_{mid,core}) / Asl_{mid} = 200000.00$
 $1 = Asl_{ten} / (b * d) * (fs_1 / f_c) = 0.04735912$
 $2 = Asl_{com} / (b * d) * (fs_2 / f_c) = 0.04735912$
 $v = Asl_{mid} / (b * d) * (fs_v / f_c) = 0.01770442$
 and confined core properties:
 $b = 690.00$
 $d = 327.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl_{ten} / (b * d) * (fs_1 / f_c) = 0.05619999$
 $2 = Asl_{com} / (b * d) * (fs_2 / f_c) = 0.05619999$
 $v = Asl_{mid} / (b * d) * (fs_v / f_c) = 0.02100943$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y_2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.16690234$
 $Mu = MR_c (4.14) = 1.7252E+008$
 $u = su (4.1) = 1.7214953E-005$

 Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Mu_1 -

 Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$$u = 1.7214953E-005$$

$$Mu = 1.7252E+008$$

 with full section properties:

$$b = 750.00$$

$$d = 357.00$$

$d' = 43.00$
 $v = 0.00124684$
 $N = 11016.808$
 $fc = 33.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0052143$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.0052143$
 $we (5.4c) = 0.00183676$
 $ase ((5.4d), TBDY) = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.12601038$
 $ase1 = 0.12601038$
 $bo_1 = 690.00$
 $ho_1 = 340.00$
 $bi2_1 = 1.1834E+006$
 $ase2 = \text{Max}(ase1, ase2) = 0.12601038$
 $bo_2 = 542.00$
 $ho_2 = 192.00$
 $bi2_2 = 661256.00$
 $psh, \min * F_{ywe} = \text{Min}(psh, x * F_{ywe}, psh, y * F_{ywe}) = 1.60339$
 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)

$psh, x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.60339$
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / A_{sec} = 0.0020944$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / A_{sec} = 0.00026808$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

$psh, y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 3.13667$
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / A_{sec} = 0.00392699$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 750.00$
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / A_{sec} = 0.00073723$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 550.00$

$A_{sec} = 300000.00$
 $s1 = 100.00$
 $s2 = 250.00$
 $fywe1 = 694.45$
 $fywe2 = 555.55$
 $f_{ce} = 33.00$

From ((5.A5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$

$y1 = 0.00140044$
 $sh1 = 0.0044814$
 $ft1 = 441.5397$
 $fy1 = 367.9498$
 $su1 = 0.00512$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lo_{u, \min} = lb/ld = 0.30$

$su1 = 0.4 * esu1_{\text{nominal}} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esu1_{\text{nominal}} = 0.08$,

For calculation of $esu1_{\text{nominal}}$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs1 / 1.2$, from table 5.1, 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 $fs1 = (fs_{\text{jacket}} * A_{sl, \text{ten, jacket}} + fs_{\text{core}} * A_{sl, \text{ten, core}}) / A_{sl, \text{ten}} = 367.9498$

with $Es1 = (Es_{\text{jacket}} * A_{sl, \text{ten, jacket}} + Es_{\text{core}} * A_{sl, \text{ten, core}}) / A_{sl, \text{ten}} = 200000.00$

$y2 = 0.00140044$


```

sh2 = 0.0044814
ft2 = 441.5397
fy2 = 367.9498
su2 = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/lb,min = 0.30
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 367.9498
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/lb = 0.30
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04735912
2 = Asl,com/(b*d)*(fs2/fc) = 0.04735912
v = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05619999
2 = Asl,com/(b*d)*(fs2/fc) = 0.05619999
v = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.16690234
Mu = MRc (4.14) = 1.7252E+008
u = su (4.1) = 1.7214953E-005

```

Calculation of ratio lb/lb

Inadequate Lap Length with lb/lb = 0.30

Calculation of Mu2+

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

u = 1.7214953E-005

$$\mu = 1.7252E+008$$

with full section properties:

$$b = 750.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00124684$$

$$N = 11016.808$$

$$f_c = 33.00$$

$$\phi (5A.5, \text{TB DY}) = 0.002$$

$$\text{Final value of } \phi: \phi^* = \text{shear_factor} * \text{Max}(\phi_c, \phi_s) = 0.0052143$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TB DY: } \phi_c = 0.0052143$$

$$\phi_s (5.4c) = 0.00183676$$

$$A_{se} ((5.4d), \text{TB DY}) = (A_{se1} * A_{ext} + A_{se2} * A_{int}) / A_{sec} = 0.12601038$$

$$A_{se1} = 0.12601038$$

$$b_{o1} = 690.00$$

$$h_{o1} = 340.00$$

$$b_{i21} = 1.1834E+006$$

$$A_{se2} = \text{Max}(A_{se1}, A_{se2}) = 0.12601038$$

$$b_{o2} = 542.00$$

$$h_{o2} = 192.00$$

$$b_{i22} = 661256.00$$

$$\phi_{sh, \min} * F_{ywe} = \text{Min}(\phi_{sh, x} * F_{ywe}, \phi_{sh, y} * F_{ywe}) = 1.60339$$

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)

$$\phi_{sh, x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.60339$$

$$\phi_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.0020944$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$\phi_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00026808$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$\phi_{sh, y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 3.13667$$

$$\phi_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00392699$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 750.00$$

$$\phi_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00073723$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 550.00$$

$$A_{sec} = 300000.00$$

$$s_1 = 100.00$$

$$s_2 = 250.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 555.55$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TB DY), TB DY: } \phi_c = 0.002$$

$$\phi_c = \text{confinement factor} = 1.00$$

$$y_1 = 0.00140044$$

$$sh_1 = 0.0044814$$

$$ft_1 = 441.5397$$

$$fy_1 = 367.9498$$

$$su_1 = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$l_o / l_{o, \min} = l_b / l_d = 0.30$$

$$su_1 = 0.4 * esu_{1, \text{nominal}} ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } esu_{1, \text{nominal}} = 0.08,$$

For calculation of $esu_{1, \text{nominal}}$ and y_1, sh_1, ft_1, fy_1 , it is considered

characteristic value $fsy1 = fs1/1.2$, 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 $fs1 = (fs_{jacket} \cdot Asl_{ten,jacket} + fs_{core} \cdot Asl_{ten,core}) / Asl_{ten} = 367.9498$
with $Es1 = (Es_{jacket} \cdot Asl_{ten,jacket} + Es_{core} \cdot Asl_{ten,core}) / Asl_{ten} = 200000.00$
 $y2 = 0.00140044$
 $sh2 = 0.0044814$
 $ft2 = 441.5397$
 $fy2 = 367.9498$
 $su2 = 0.00512$
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $lo/lo_{u,min} = lb/lb_{min} = 0.30$
 $su2 = 0.4 \cdot esu2_{nominal} ((5.5), TBDY) = 0.032$
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 $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fs2 = (fs_{jacket} \cdot Asl_{com,jacket} + fs_{core} \cdot Asl_{com,core}) / Asl_{com} = 367.9498$
with $Es2 = (Es_{jacket} \cdot Asl_{com,jacket} + Es_{core} \cdot Asl_{com,core}) / Asl_{com} = 200000.00$
 $yv = 0.00140044$
 $shv = 0.0044814$
 $ftv = 466.8167$
 $fyv = 389.0139$
 $suv = 0.00512$
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $lo/lo_{u,min} = lb/ld = 0.30$
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$
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 $fsv = (fs_{jacket} \cdot Asl_{mid,jacket} + fs_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 389.0139$
with $Es_v = (Es_{jacket} \cdot Asl_{mid,jacket} + Es_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 200000.00$
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.04735912$
 $2 = Asl_{com} / (b \cdot d) \cdot (fs2 / fc) = 0.04735912$
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.01770442$
and confined core properties:
 $b = 690.00$
 $d = 327.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.05619999$
 $2 = Asl_{com} / (b \cdot d) \cdot (fs2 / fc) = 0.05619999$
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.02100943$
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
--->
 $su (4.9) = 0.16690234$
 $Mu = MRc (4.14) = 1.7252E+008$
 $u = su (4.1) = 1.7214953E-005$

Calculation of ratio lb/ld

Inadequate Lap Length with $lb/ld = 0.30$

Calculation of $Mu2$ -

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$$\phi_u = 1.7214953E-005$$

$$\mu = 1.7252E+008$$

with full section properties:

$$b = 750.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$\nu = 0.00124684$$

$$N = 11016.808$$

$$f_c = 33.00$$

$$\phi_{co} (5A.5, TBDY) = 0.002$$

$$\text{Final value of } \phi_{cu}: \phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.0052143$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.0052143$$

$$\phi_{we} (5.4c) = 0.00183676$$

$$\phi_{ase} ((5.4d), TBDY) = (\phi_{ase1} * A_{ext} + \phi_{ase2} * A_{int}) / A_{sec} = 0.12601038$$

$$\phi_{ase1} = 0.12601038$$

$$b_{o_1} = 690.00$$

$$h_{o_1} = 340.00$$

$$\phi_{bi2_1} = 1.1834E+006$$

$$\phi_{ase2} = \text{Max}(\phi_{ase1}, \phi_{ase2}) = 0.12601038$$

$$b_{o_2} = 542.00$$

$$h_{o_2} = 192.00$$

$$\phi_{bi2_2} = 661256.00$$

$$\phi_{psh,min} * F_{ywe} = \text{Min}(\phi_{psh,x} * F_{ywe}, \phi_{psh,y} * F_{ywe}) = 1.60339$$

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)

$$\phi_{psh,x} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{ps2} * F_{ywe2} = 1.60339$$

$$\phi_{ps1} \text{ (external)} = (\phi_{Ash1} * h_1 / s_1) / A_{sec} = 0.0020944$$

$$\phi_{Ash1} = \phi_{Astir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$\phi_{ps2} \text{ (internal)} = (\phi_{Ash2} * h_2 / s_2) / A_{sec} = 0.00026808$$

$$\phi_{Ash2} = \phi_{Astir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$\phi_{psh,y} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{ps2} * F_{ywe2} = 3.13667$$

$$\phi_{ps1} \text{ (external)} = (\phi_{Ash1} * h_1 / s_1) / A_{sec} = 0.00392699$$

$$\phi_{Ash1} = \phi_{Astir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 750.00$$

$$\phi_{ps2} \text{ (internal)} = (\phi_{Ash2} * h_2 / s_2) / A_{sec} = 0.00073723$$

$$\phi_{Ash2} = \phi_{Astir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 550.00$$

$$A_{sec} = 300000.00$$

$$s_1 = 100.00$$

$$s_2 = 250.00$$

$$f_{ywe1} = 694.45$$

$$f_{ywe2} = 555.55$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_{cc} = 0.002$$

$$\phi_c = \text{confinement factor} = 1.00$$

$$\phi_{y1} = 0.00140044$$

$$\phi_{sh1} = 0.0044814$$

$$\phi_{ft1} = 441.5397$$

$$\phi_{fy1} = 367.9498$$

$$\phi_{su1} = 0.00512$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

```

Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 367.9498
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.00140044
sh2 = 0.0044814
ft2 = 441.5397
fy2 = 367.9498
su2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 367.9498
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.00140044
shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04735912
2 = Asl,com/(b*d)*(fs2/fc) = 0.04735912
v = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
c = confinement factor = 1.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05619999
2 = Asl,com/(b*d)*(fs2/fc) = 0.05619999
v = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.16690234
Mu = MRc (4.14) = 1.7252E+008
u = su (4.1) = 1.7214953E-005

```

Calculation of ratio lb/ld

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 600261.003$

Calculation of Shear Strength at edge 1, $V_{r1} = 600261.003$

$V_{r1} = V_{Col} \text{ ((10.3), ASCE 41-17)} = k_n l^* V_{Col0}$

$V_{Col0} = 600261.003$

$k_n l = 1$ (zero step-static loading)

NOTE: In expression (10-3) ' $V_s = A_v f_y d/s$ ' is replaced by ' $V_s + f^* V_f$ ' where V_f is the contribution of FRPs (11.3), ACI 440).

$= 1$ (normal-weight concrete)

Mean concrete strength: $f_c' = (f_c'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f_c'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 28.23333$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$M/Vd = 2.00$

$\mu_u = 1.0002017E-011$

$\nu_u = 1.3927229E-031$

$d = 0.8 \cdot h = 320.00$

$N_u = 11016.808$

$A_g = 300000.00$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} = 279254.914$

where:

$V_{s1} = 279254.914$ is calculated for jacket, with:

$d = 320.00$

$A_v = 157079.633$

$f_y = 555.56$

$s = 100.00$

V_{s1} is multiplied by $Col1 = 1.00$

$s/d = 0.3125$

$V_{s2} = 0.00$ is calculated for core, with:

$d = 160.00$

$A_v = 100530.965$

$f_y = 444.44$

$s = 250.00$

V_{s2} is multiplied by $Col2 = 0.00$

$s/d = 1.5625$

$V_f \text{ ((11-3)-(11.4), ACI 440)} = 0.00$

From (11-11), ACI 440: $V_s + V_f \leq 847147.582$

$b_w = 750.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 600261.003$

$V_{r2} = V_{Col} \text{ ((10.3), ASCE 41-17)} = k_n l^* V_{Col0}$

$V_{Col0} = 600261.003$

$k_n l = 1$ (zero step-static loading)

NOTE: In expression (10-3) ' $V_s = A_v f_y d/s$ ' is replaced by ' $V_s + f^* V_f$ ' where V_f is the contribution of FRPs (11.3), ACI 440).

$= 1$ (normal-weight concrete)

Mean concrete strength: $f_c' = (f_c'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f_c'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 28.23333$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$M/Vd = 2.00$

$\mu_u = 1.0002017E-011$

$\nu_u = 1.3927229E-031$

$d = 0.8 \cdot h = 320.00$

$N_u = 11016.808$

$A_g = 300000.00$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} = 279254.914$

where:

$V_{s1} = 279254.914$ is calculated for jacket, with:

$d = 320.00$

$A_v = 157079.633$

$f_y = 555.56$
 $s = 100.00$
 Vs1 is multiplied by Col1 = 1.00
 $s/d = 0.3125$
 Vs2 = 0.00 is calculated for core, with:
 $d = 160.00$
 $A_v = 100530.965$
 $f_y = 444.44$
 $s = 250.00$
 Vs2 is multiplied by Col2 = 0.00
 $s/d = 1.5625$
 $V_f ((11-3)-(11.4), \text{ACI } 440) = 0.00$
 From (11-11), ACI 440: $V_s + V_f \leq 847147.582$
 $b_w = 750.00$

 End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
 At local axis: 3

 Start Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
 At Shear local axis: 2
 (Bending local axis: 3)
 Section Type: rcjrs

Constant Properties

 Knowledge Factor, $\phi = 1.00$
 Mean strength values are used for both shear and moment calculations.
 Consequently:
 Jacket
 New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
 New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.56$
 Concrete Elasticity, $E_c = 26999.444$
 Steel Elasticity, $E_s = 200000.00$
 Existing Column
 Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 20.00$
 Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 444.44$
 Concrete Elasticity, $E_c = 21019.039$
 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, $f_s = 1.25 \cdot f_{sm} = 694.45$
 Existing Column
 Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 555.55$
 #####
 External Height, $H = 400.00$
 External Width, $W = 750.00$
 Internal Height, $H = 200.00$
 Internal Width, $W = 550.00$
 Cover Thickness, $c = 25.00$
 Mean Confinement Factor overall section = 1.00
 Element Length, $L = 3000.00$
 Secondary Member
 Ribbed Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Inadequate Lap Length with $l_o/l_{o,min} = 0.30$
 No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, $V_a = -3.9443045E-031$
EDGE -B-
Shear Force, $V_b = 3.9443045E-031$
BOTH EDGES
Axial Force, $F = -11016.808$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $As_t = 0.00$
-Compression: $As_c = 2676.637$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $As_{t,ten} = 1137.257$
-Compression: $As_{l,com} = 1137.257$
-Middle: $As_{l,mid} = 402.1239$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.25537128$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 235770.47$
with
 $M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 3.5366E+008$
 $Mu_{1+} = 3.5366E+008$, 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
 $Mu_{1-} = 3.5366E+008$, 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
 $M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 3.5366E+008$
 $Mu_{2+} = 3.5366E+008$, 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
 $Mu_{2-} = 3.5366E+008$, 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

Calculation of Mu_{1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 8.5738376E-006$
 $M_u = 3.5366E+008$

with full section properties:

$b = 400.00$
 $d = 707.00$
 $d' = 43.00$
 $v = 0.00118049$
 $N = 11016.808$
 $f_c = 33.00$
 $\phi_c (5A.5, TBDY) = 0.002$
Final value of ϕ_u : $\phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.0052143$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $\phi_u = 0.0052143$
 $\phi_{ue} (5.4c) = 0.00183676$
 $\phi_{se} ((5.4d), TBDY) = (\phi_{se1} * A_{ext} + \phi_{se2} * A_{int}) / A_{sec} = 0.12601038$
 $\phi_{se1} = 0.12601038$
 $\phi_{se1_1} = 690.00$
 $\phi_{se1_2} = 340.00$
 $\phi_{se2_1} = 1.1834E+006$
 $\phi_{se2} = \text{Max}(\phi_{se1}, \phi_{se2}) = 0.12601038$
 $\phi_{se2_1} = 542.00$
 $\phi_{se2_2} = 192.00$
 $\phi_{se2_2_1} = 661256.00$
 $\phi_{sh,min} * F_{ywe} = \text{Min}(\phi_{sh,x} * F_{ywe}, \phi_{sh,y} * F_{ywe}) = 1.60339$
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)

$psh_x \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 1.60339$
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.0020944$
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$
 No stirups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00026808$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 No stirups, $ns_2 = 2.00$
 $h2 = 200.00$

$psh_y \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 3.13667$
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00392699$
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$
 No stirups, $ns_1 = 2.00$
 $h1 = 750.00$
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00073723$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 No stirups, $ns_2 = 2.00$
 $h2 = 550.00$

$Asec = 300000.00$

$s1 = 100.00$

$s2 = 250.00$

$fywe1 = 694.45$

$fywe2 = 555.55$

$fce = 33.00$

From ((5.A.5), TBDY), TBDY: $cc = 0.002$

$c = \text{confinement factor} = 1.00$

$y1 = 0.00140044$

$sh1 = 0.0044814$

$ft1 = 441.5397$

$fy1 = 367.9498$

$su1 = 0.00512$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$lo/lou, \min = lb/ld = 0.30$

$su1 = 0.4 \cdot esu1_nominal \text{ ((5.5), TBDY)} = 0.032$

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 $fs1 = (fs_jacket \cdot Asl, \text{ten, jacket} + fs_core \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 367.9498$

with $Es1 = (Es_jacket \cdot Asl, \text{ten, jacket} + Es_core \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$

$y2 = 0.00140044$

$sh2 = 0.0044814$

$ft2 = 441.5397$

$fy2 = 367.9498$

$su2 = 0.00512$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$lo/lou, \min = lb/lb, \min = 0.30$

$su2 = 0.4 \cdot esu2_nominal \text{ ((5.5), TBDY)} = 0.032$

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 $fs2 = (fs_jacket \cdot Asl, \text{com, jacket} + fs_core \cdot Asl, \text{com, core}) / Asl, \text{com} = 367.9498$

with $Es2 = (Es_jacket \cdot Asl, \text{com, jacket} + Es_core \cdot Asl, \text{com, core}) / Asl, \text{com} = 200000.00$

$yv = 0.00140044$

$shv = 0.0044814$

$ftv = 466.8167$

$fyv = 389.0139$

$suv = 0.00512$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.30$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and yv, shv,ftv,fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1,ft1,fy1$, are also multiplied by $Min(1,1.25*(l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs_{jacket} * Asl_{mid,jacket} + fs_{mid} * Asl_{mid,core}) / Asl_{mid} = 389.0139$
 with $Esv = (Es_{jacket} * Asl_{mid,jacket} + Es_{mid} * Asl_{mid,core}) / Asl_{mid} = 200000.00$
 $1 = Asl_{ten} / (b * d) * (fs1 / fc) = 0.04483877$
 $2 = Asl_{com} / (b * d) * (fs2 / fc) = 0.04483877$
 $v = Asl_{mid} / (b * d) * (fsv / fc) = 0.01676222$

and confined core properties:

$b = 340.00$
 $d = 677.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = Asl_{ten} / (b * d) * (fs1 / fc) = 0.05508907$
 $2 = Asl_{com} / (b * d) * (fs2 / fc) = 0.05508907$
 $v = Asl_{mid} / (b * d) * (fsv / fc) = 0.02059413$

Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->
 $su (4.9) = 0.1553529$
 $Mu = MRc (4.14) = 3.5366E+008$
 $u = su (4.1) = 8.5738376E-006$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of $Mu1$ -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$u = 8.5738376E-006$
 $Mu = 3.5366E+008$

with full section properties:

$b = 400.00$
 $d = 707.00$
 $d' = 43.00$
 $v = 0.00118049$
 $N = 11016.808$
 $fc = 33.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0052143$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.0052143$
 $we (5.4c) = 0.00183676$
 $ase ((5.4d), TBDY) = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.12601038$
 $ase1 = 0.12601038$
 $bo_1 = 690.00$
 $ho_1 = 340.00$
 $bi2_1 = 1.1834E+006$
 $ase2 = \text{Max}(ase1, ase2) = 0.12601038$
 $bo_2 = 542.00$

$ho_2 = 192.00$
 $bi2_2 = 661256.00$
 $psh,min*Fywe = \text{Min}(psh,x*Fywe, psh,y*Fywe) = 1.60339$
 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)

$psh_x*Fywe = psh1*Fywe1 + ps2*Fywe2 = 1.60339$
 $ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.0020944$
 $Ash1 = Astir_1*ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00026808$
 $Ash2 = Astir_2*ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

$psh_y*Fywe = psh1*Fywe1 + ps2*Fywe2 = 3.13667$
 $ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00392699$
 $Ash1 = Astir_1*ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 750.00$
 $ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00073723$
 $Ash2 = Astir_2*ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 550.00$

$Asec = 300000.00$
 $s1 = 100.00$
 $s2 = 250.00$
 $fywe1 = 694.45$
 $fywe2 = 555.55$
 $fce = 33.00$

From ((5.A5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$

$y1 = 0.00140044$
 $sh1 = 0.0044814$
 $ft1 = 441.5397$
 $fy1 = 367.9498$
 $su1 = 0.00512$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lou,min = lb/ld = 0.30$

$su1 = 0.4*esu1_nominal \text{ ((5.5), TBDY)} = 0.032$

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 $fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 367.9498$

with $Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00$

$y2 = 0.00140044$
 $sh2 = 0.0044814$
 $ft2 = 441.5397$
 $fy2 = 367.9498$
 $su2 = 0.00512$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lou,min = lb/lb,min = 0.30$

$su2 = 0.4*esu2_nominal \text{ ((5.5), TBDY)} = 0.032$

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 $fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 367.9498$

with $Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00$

$yv = 0.00140044$

```

shv = 0.0044814
ftv = 466.8167
fyv = 389.0139
suv = 0.00512
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/ld = 0.30
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 389.0139
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.04483877
    2 = Asl,com/(b*d)*(fs2/fc) = 0.04483877
    v = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 33.00
cc (5A.5, TBDY) = 0.002
    c = confinement factor = 1.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.05508907
    2 = Asl,com/(b*d)*(fs2/fc) = 0.05508907
    v = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.1553529
Mu = MRc (4.14) = 3.5366E+008
u = su (4.1) = 8.5738376E-006

```

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

```

u = 8.5738376E-006
Mu = 3.5366E+008

```

with full section properties:

```

b = 400.00
d = 707.00
d' = 43.00
v = 0.00118049
N = 11016.808
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.0052143
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0052143
we (5.4c) = 0.00183676
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.12601038
ase1 = 0.12601038

```

$bo_1 = 690.00$
 $ho_1 = 340.00$
 $bi2_1 = 1.1834E+006$
 $ase2 = \text{Max}(ase1, ase2) = 0.12601038$
 $bo_2 = 542.00$
 $ho_2 = 192.00$
 $bi2_2 = 661256.00$
 $psh, min * Fywe = \text{Min}(psh, x * Fywe, psh, y * Fywe) = 1.60339$
 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)

$psh_x * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 1.60339$
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.0020944$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00026808$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

$psh_y * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 3.13667$
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.00392699$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 750.00$
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00073723$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 550.00$

$Asec = 300000.00$
 $s1 = 100.00$
 $s2 = 250.00$
 $fywe1 = 694.45$
 $fywe2 = 555.55$
 $fce = 33.00$
 From ((5.A5), TBDY), TBDY: $cc = 0.002$
 $c = \text{confinement factor} = 1.00$
 $y1 = 0.00140044$
 $sh1 = 0.0044814$
 $ft1 = 441.5397$
 $fy1 = 367.9498$
 $su1 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00
 $lo/lo, min = lb/l_d = 0.30$
 $su1 = 0.4 * esu1_nominal \text{ ((5.5), TBDY)} = 0.032$
 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 $fs1 = (fs_jacket * Asl, ten, jacket + fs_core * Asl, ten, core) / Asl, ten = 367.9498$
 with $Es1 = (Es_jacket * Asl, ten, jacket + Es_core * Asl, ten, core) / Asl, ten = 200000.00$
 $y2 = 0.00140044$
 $sh2 = 0.0044814$
 $ft2 = 441.5397$
 $fy2 = 367.9498$
 $su2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00
 $lo/lo, min = lb/l_b, min = 0.30$
 $su2 = 0.4 * esu2_nominal \text{ ((5.5), TBDY)} = 0.032$
 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 $f_{s2} = (f_{sjacket} \cdot A_{sl,com,jacket} + f_{s,core} \cdot A_{sl,com,core})/A_{sl,com} = 367.9498$
 with $E_{s2} = (E_{sjacket} \cdot A_{sl,com,jacket} + E_{s,core} \cdot A_{sl,com,core})/A_{sl,com} = 200000.00$
 $y_v = 0.00140044$
 $sh_v = 0.0044814$
 $ft_v = 466.8167$
 $fy_v = 389.0139$
 $suv = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.30$
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$
 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 $f_{sv} = (f_{sjacket} \cdot A_{sl,mid,jacket} + f_{s,mid} \cdot A_{sl,mid,core})/A_{sl,mid} = 389.0139$
 with $E_{sv} = (E_{sjacket} \cdot A_{sl,mid,jacket} + E_{s,mid} \cdot A_{sl,mid,core})/A_{sl,mid} = 200000.00$
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.04483877$
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.04483877$
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.01676222$
 and confined core properties:
 $b = 340.00$
 $d = 677.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 33.00$
 $cc (5A.5, TBDY) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.05508907$
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.05508907$
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.02059413$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.1553529$
 $Mu = MR_c (4.14) = 3.5366E+008$
 $u = su (4.1) = 8.5738376E-006$

Calculation of ratio l_b/l_d

Inadequate Lap Length with $l_b/l_d = 0.30$

Calculation of Mu_2 -

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$u = 8.5738376E-006$
 $Mu = 3.5366E+008$

with full section properties:

$b = 400.00$
 $d = 707.00$
 $d' = 43.00$
 $v = 0.00118049$
 $N = 11016.808$
 $f_c = 33.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of ϕ_u : $\phi_u^* = \text{shear_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.0052143$

The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $c_u = 0.0052143$
 we (5.4c) = 0.00183676
 $ase((5.4d), TBDY) = (ase1 \cdot A_{ext} + ase2 \cdot A_{int}) / A_{sec} = 0.12601038$
 $ase1 = 0.12601038$
 $bo_1 = 690.00$
 $ho_1 = 340.00$
 $bi2_1 = 1.1834E+006$
 $ase2 = \text{Max}(ase1, ase2) = 0.12601038$
 $bo_2 = 542.00$
 $ho_2 = 192.00$
 $bi2_2 = 661256.00$
 $psh, \min \cdot F_{ywe} = \text{Min}(psh, x \cdot F_{ywe}, psh, y \cdot F_{ywe}) = 1.60339$
 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)

 $psh, x \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 1.60339$
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / A_{sec} = 0.0020944$
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / A_{sec} = 0.00026808$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

 $psh, y \cdot F_{ywe} = psh1 \cdot F_{ywe1} + ps2 \cdot F_{ywe2} = 3.13667$
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / A_{sec} = 0.00392699$
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 750.00$
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / A_{sec} = 0.00073723$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 550.00$

 $A_{sec} = 300000.00$
 $s1 = 100.00$
 $s2 = 250.00$
 $fywe1 = 694.45$
 $fywe2 = 555.55$
 $f_{ce} = 33.00$
 From ((5.A5), TBDY), TBDY: $c_c = 0.002$
 $c = \text{confinement factor} = 1.00$
 $y1 = 0.00140044$
 $sh1 = 0.0044814$
 $ft1 = 441.5397$
 $fy1 = 367.9498$
 $su1 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lo, \min = lb/ld = 0.30$
 $su1 = 0.4 \cdot esu1_nominal((5.5), TBDY) = 0.032$
 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 $fs1 = (f_{s, \text{jacket}} \cdot A_{s, \text{ten, jacket}} + f_{s, \text{core}} \cdot A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 367.9498$
 with $Es1 = (E_{s, \text{jacket}} \cdot A_{s, \text{ten, jacket}} + E_{s, \text{core}} \cdot A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 200000.00$
 $y2 = 0.00140044$
 $sh2 = 0.0044814$
 $ft2 = 441.5397$
 $fy2 = 367.9498$
 $su2 = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with

$\text{Shear_factor} = 1.00$
 $\text{lo/lou,min} = \text{lb/lb,min} = 0.30$
 $\text{su}_2 = 0.4 \cdot \text{esu}_2\text{nominal} ((5.5), \text{TB DY}) = 0.032$
 From table 5A.1, TB DY: $\text{esu}_2\text{nominal} = 0.08$,
 For calculation of $\text{esu}_2\text{nominal}$ and $y_2, \text{sh}_2, \text{ft}_2, \text{fy}_2$, it is considered
 characteristic value $\text{fsy}_2 = \text{fs}_2/1.2$, from table 5.1, TB DY.
 $y_1, \text{sh}_1, \text{ft}_1, \text{fy}_1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.
 with $\text{fs}_2 = (\text{fs}_{\text{jacket}} \cdot \text{Asl,com,jacket} + \text{fs}_{\text{core}} \cdot \text{Asl,com,core}) / \text{Asl,com} = 367.9498$
 with $\text{Es}_2 = (\text{Es}_{\text{jacket}} \cdot \text{Asl,com,jacket} + \text{Es}_{\text{core}} \cdot \text{Asl,com,core}) / \text{Asl,com} = 200000.00$
 $y_v = 0.00140044$
 $\text{sh}_v = 0.0044814$
 $\text{ft}_v = 466.8167$
 $\text{fy}_v = 389.0139$
 $\text{su}_v = 0.00512$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $\text{lo/lou,min} = \text{lb}/\text{ld} = 0.30$
 $\text{su}_v = 0.4 \cdot \text{esuv_nominal} ((5.5), \text{TB DY}) = 0.032$
 From table 5A.1, TB DY: $\text{esuv_nominal} = 0.08$,
 considering characteristic value $\text{fsy}_v = \text{fs}_v/1.2$, from table 5.1, TB DY
 For calculation of esuv_nominal and $y_v, \text{sh}_v, \text{ft}_v, \text{fy}_v$, it is considered
 characteristic value $\text{fsy}_v = \text{fs}_v/1.2$, from table 5.1, TB DY.
 $y_1, \text{sh}_1, \text{ft}_1, \text{fy}_1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.
 with $\text{fs}_v = (\text{fs}_{\text{jacket}} \cdot \text{Asl,mid,jacket} + \text{fs}_{\text{mid}} \cdot \text{Asl,mid,core}) / \text{Asl,mid} = 389.0139$
 with $\text{Es}_v = (\text{Es}_{\text{jacket}} \cdot \text{Asl,mid,jacket} + \text{Es}_{\text{mid}} \cdot \text{Asl,mid,core}) / \text{Asl,mid} = 200000.00$
 $1 = \text{Asl,ten}/(\text{b} \cdot \text{d}) \cdot (\text{fs}_1/\text{fc}) = 0.04483877$
 $2 = \text{Asl,com}/(\text{b} \cdot \text{d}) \cdot (\text{fs}_2/\text{fc}) = 0.04483877$
 $v = \text{Asl,mid}/(\text{b} \cdot \text{d}) \cdot (\text{fs}_v/\text{fc}) = 0.01676222$
 and confined core properties:
 $b = 340.00$
 $d = 677.00$
 $d' = 13.00$
 $\text{fcc} (5A.2, \text{TB DY}) = 33.00$
 $\text{cc} (5A.5, \text{TB DY}) = 0.002$
 $c = \text{confinement factor} = 1.00$
 $1 = \text{Asl,ten}/(\text{b} \cdot \text{d}) \cdot (\text{fs}_1/\text{fc}) = 0.05508907$
 $2 = \text{Asl,com}/(\text{b} \cdot \text{d}) \cdot (\text{fs}_2/\text{fc}) = 0.05508907$
 $v = \text{Asl,mid}/(\text{b} \cdot \text{d}) \cdot (\text{fs}_v/\text{fc}) = 0.02059413$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

Calculation of ratio lb/ld

Inadequate Lap Length with $\text{lb}/\text{ld} = 0.30$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 923245.821$

Calculation of Shear Strength at edge 1, $V_{r1} = 923245.821$

$V_{r1} = V_{\text{Col}} ((10.3), \text{ASCE 41-17}) = \text{knl} \cdot V_{\text{ColO}}$

$V_{\text{ColO}} = 923245.821$

$\text{knl} = 1$ (zero step-static loading)

NOTE: In expression (10-3) ' $V_s = A_v \cdot \text{fy} \cdot \text{d}/s$ ' is replaced by ' $V_s + f \cdot V_f$ '
 where V_f is the contribution of FRPs (11.3), ACI 440).

$= 1$ (normal-weight concrete)

Mean concrete strength: $f_c' = (f_c'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f_c'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 28.23333$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$M/Vd = 2.00$

$\mu_u = 6.8236829 \times 10^{-12}$

$\mu_v = 3.9443045 \times 10^{-31}$

$d = 0.8 \cdot h = 600.00$

$N_u = 11016.808$

$A_g = 300000.00$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} = 602239.733$

where:

$V_{s1} = 523602.964$ is calculated for jacket, with:

$d = 600.00$

$A_v = 157079.633$

$f_y = 555.56$

$s = 100.00$

V_{s1} is multiplied by $\text{Col1} = 1.00$

$s/d = 0.16666667$

$V_{s2} = 78636.768$ is calculated for core, with:

$d = 440.00$

$A_v = 100530.965$

$f_y = 444.44$

$s = 250.00$

V_{s2} is multiplied by $\text{Col2} = 1.00$

$s/d = 0.56818182$

V_f ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: $V_s + V_f \leq 847147.582$

$b_w = 400.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 923245.821$

$V_{r2} = V_{\text{Col}} ((10.3), \text{ASCE } 41-17) = k_{nl} \cdot V_{\text{ColO}}$

$V_{\text{ColO}} = 923245.821$

$k_{nl} = 1$ (zero step-static loading)

NOTE: In expression (10-3) ' $V_s = A_v \cdot f_y \cdot d / s$ ' is replaced by ' $V_s + f \cdot V_f$ ' where V_f is the contribution of FRPs (11.3), ACI 440).

= 1 (normal-weight concrete)

Mean concrete strength: $f_c' = (f_c'_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f_c'_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 28.23333$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$M/Vd = 2.00$

$\mu_u = 6.8236829 \times 10^{-12}$

$\mu_v = 3.9443045 \times 10^{-31}$

$d = 0.8 \cdot h = 600.00$

$N_u = 11016.808$

$A_g = 300000.00$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} = 602239.733$

where:

$V_{s1} = 523602.964$ is calculated for jacket, with:

$d = 600.00$

$A_v = 157079.633$

$f_y = 555.56$

$s = 100.00$

V_{s1} is multiplied by $\text{Col1} = 1.00$

$s/d = 0.16666667$

$V_{s2} = 78636.768$ is calculated for core, with:

$d = 440.00$

$A_v = 100530.965$

$f_y = 444.44$

$s = 250.00$

V_{s2} is multiplied by $\text{Col2} = 1.00$

$s/d = 0.56818182$

V_f ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: $V_s + V_f \leq 847147.582$

$b_w = 400.00$

End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rcjrs

Constant Properties

Knowledge Factor, $\gamma = 1.00$
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, $f_c = f_{cm} = 33.00$
New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.56$
Concrete Elasticity, $E_c = 26999.444$
Steel Elasticity, $E_s = 200000.00$
Existing Column
Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 20.00$
Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 444.44$
Concrete Elasticity, $E_c = 21019.039$
Steel Elasticity, $E_s = 200000.00$
External Height, $H = 400.00$
External Width, $W = 750.00$
Internal Height, $H = 200.00$
Internal Width, $W = 550.00$
Cover Thickness, $c = 25.00$
Element Length, $L = 3000.00$
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with $l_b/l_d = 0.30$
No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 1.2625E+006$
Shear Force, $V_2 = 2823.172$
Shear Force, $V_3 = 3.1363135E-013$
Axial Force, $F = -15251.406$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{sl,t} = 0.00$
-Compression: $A_{sl,c} = 2676.637$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{sl,ten} = 1137.257$
-Compression: $A_{sl,com} = 1137.257$
-Middle: $A_{sl,mid} = 402.1239$
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{sl,ten,jacket} = 829.3805$
-Compression: $A_{sl,com,jacket} = 829.3805$
-Middle: $A_{sl,mid,jacket} = 402.1239$
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{sl,ten,core} = 307.8761$
-Compression: $A_{sl,com,core} = 307.8761$
-Middle: $A_{sl,mid,core} = 0.00$
Mean Diameter of Tension Reinforcement, $Db_L = 16.80$

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = u = 0.03007809$
 $u = y + p = 0.03007809$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.00034279$ ((4.29), Biskinis Phd))
 $M_y = 2.5050E+008$
 $L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 447.1746
From table 10.5, ASCE 41_17: $E_{eff} = factor * E_c * I_g = 1.0893E+014$
 $factor = 0.30$
 $A_g = 300000.00$
Mean concrete strength: $f'_c = (f'_{c_jacket} * Area_jacket + f'_{c_core} * Area_core) / Area_section = 28.23333$
 $N = 15251.406$
 $E_c * I_g = E_{c_jacket} * I_{g_jacket} + E_{c_core} * I_{g_core} = 3.6310E+014$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

$y = \min(y_{ten}, y_{com})$
 $y_{ten} = 2.6754055E-006$
with ((10.1), ASCE 41-17) $f_y = \min(f_y, 1.25 * f_y * (I_b / I_d)^{2/3}) = 296.8915$
 $d = 707.00$
 $y = 0.21520049$
 $A = 0.00964642$
 $B = 0.00520186$
with $p_t = 0.00402142$
 $p_c = 0.00402142$
 $p_v = 0.00142194$
 $N = 15251.406$
 $b = 400.00$
 $" = 0.06082037$
 $y_{comp} = 1.4667378E-005$
with $f_c = 33.00$
 $E_c = 26999.444$
 $y = 0.21215815$
 $A = 0.0093422$
 $B = 0.00502021$
with $E_s = 200000.00$

Calculation of ratio I_b / I_d

Inadequate Lap Length with $I_b / I_d = 0.30$

- Calculation of p -

From table 10-8: $p = 0.02973531$

with:

- Columns controlled by inadequate development or splicing along the clear height because $I_b / I_d < 1$
shear control ratio $V_y E / V_{col} E = 0.25537128$
 $d = d_{external} = 707.00$
 $s = s_{external} = 0.00$
 $t = s_1 + s_2 + 2 * t_f / b_w * (f_{fe} / f_s) = 0.00466422$
jacket: $s_1 = A_{v1} * h_1 / (s_1 * A_g) = 0.00392699$
 $A_{v1} = 157.0796$, is the total area of all stirrups parallel to loading (shear) direction
 $h_1 = 750.00$
 $s_1 = 100.00$
core: $s_2 = A_{v2} * h_2 / (s_2 * A_g) = 0.00073723$
 $A_{v2} = 100.531$, is the total area of all stirrups parallel to loading (shear) direction
 $h_2 = 550.00$

$$s2 = 250.00$$

The term $2*tf/bw*(ffe/fs)$ is implemented to account for FRP contribution

where $f = 2*tf/bw$ is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises f to steel strength

All these variables have already been given in Shear control ratio calculation.

For the normalisation fs of jacket is used.

$$NUD = 15251.406$$

$$Ag = 300000.00$$

$$f_{cE} = (f_{c_jacket} * Area_jacket + f_{c_core} * Area_core) / section_area = 28.23333$$

$$f_{yE} = (f_{y_ext_Long_Reinf} * Area_ext_Long_Reinf + f_{y_int_Long_Reinf} * Area_int_Long_Reinf) / Area_Tot_Long_Rein = 529.9972$$

$$f_{ytE} = (f_{y_ext_Trans_Reinf} * s1 + f_{y_int_Trans_Reinf} * s2) / (s1 + s2) = 537.9964$$

$$p_l = Area_Tot_Long_Rein / (b * d) = 0.00946477$$

$$b = 400.00$$

$$d = 707.00$$

$$f_{cE} = 28.23333$$

End Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1

At local axis: 3

Integration Section: (b)
