

Detailed Member Calculations

Units: N&mm

Regulation: ASCE 41-17

Calculation No. 1

beam B1, Floor 1

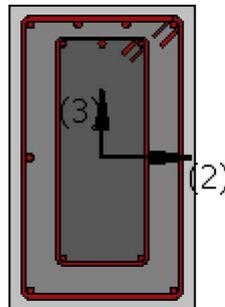
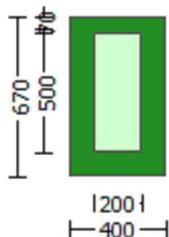
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: Start

Local Axis: (2)



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

At local axis: 2

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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
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, $E_s = 200000.00$
External Height, $H = 670.00$
External Width, $W = 400.00$
Internal Height, $H = 500.00$
Internal Width, $W = 200.00$
Cover Thickness, $c = 25.00$
Element Length, $L = 3000.00$
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length $l_o = l_b = 300.00$
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, $M_a = 1.8803257E-010$
Shear Force, $V_a = 1.0300085E-013$
EDGE -B-
Bending Moment, $M_b = 1.2067021E-010$
Shear Force, $V_b = -1.0300085E-013$
BOTH EDGES
Axial Force, $F = -4363.489$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{s,t} = 709.9999$
-Compression: $A_{s,c} = 1668.186$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{s,ten} = 911.0619$
-Compression: $A_{s,com} = 911.0619$
-Middle: $A_{s,mid} = 556.0619$
Mean Diameter of Tension Reinforcement, $D_{bL,ten} = 15.20$

New component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = 1.0 \cdot V_n = 339071.608$
 V_n ((22.5.1.1), ACI 318-14) = 339071.608

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

From Table (22.5.5.1), ACI 318-14: $V_c = 171520.00$
= 1 (normal-weight concrete)
Mean concrete strength: $f_c' = (f_c'_{jacket} \cdot Area_{jacket} + f_c'_{core} \cdot Area_{core}) / Area_{section} = 25.00$, but $f_c'^{0.5} \leq 8.3$
MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 670.00$
 $d = 320.00$
 $V_u \cdot d / M_u < 1 = 0.00$
 $M_u = 1.8803257E-010$
 $V_u = 1.0300085E-013$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 167551.608$
 $V_{s1} = 167551.608$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 500.00$
 $s = 150.00$

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

Vs2 = 0.00 is calculated for core, with:

$d = 160.00$

$A_v = 100530.965$

$f_y = 500.00$

$s = 300.00$

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

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

From (11-11), ACI 440: $V_s + V_f \leq 712133.705$

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

At local axis: 2

Integration Section: (a)

Calculation No. 2

beam B1, Floor 1

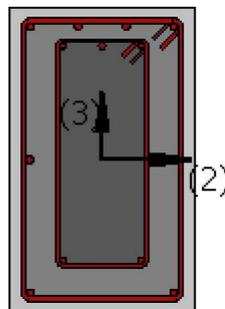
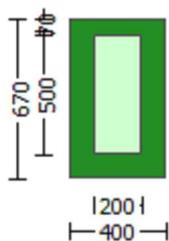
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (θ)

Edge: Start

Local Axis: (2)



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

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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, $f_s = f_{sm} = 555.5556$

Concrete Elasticity, $E_c = 26999.444$

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Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.5556
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
#####
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.4444
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.4444
#####
External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03245
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping
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Stepwise Properties
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At local axis: 3
EDGE -A-
Shear Force, Va = 9840.633
EDGE -B-
Shear Force, Vb = 9840.633
BOTH EDGES
Axial Force, F = -2237.255
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 709.9999
-Compression: Aslc = 1668.186
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 709.9999
-Compression: Asl,com = 1266.062
-Middle: Asl,mid = 402.1239
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Calculation of Shear Capacity ratio , Ve/Vr = 0.2867466
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln ± wu*ln/2 = 160061.187
with
Mpr1 = Max(Mu1+ , Mu1-) = 2.2533E+008
Mu1+ = 1.1683E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
Mu1- = 2.2533E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 2.2533E+008
Mu2+ = 1.1683E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
Mu2- = 2.2533E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination
and
± wu*ln = (|V1| + |V2|)/2
with

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V1 = 9840.633, is the shear force acting at edge 1 for the the static loading combination
V2 = 9840.633, is the shear force acting at edge 2 for the the static loading combination

Calculation of Mu1+

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

$$\mu = 6.1426221E-006$$

$$Mu = 1.1683E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00650344$$

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

$$\text{From (5.4b), TBDY: } c_u = 0.00650344$$

$$w_e \text{ (5.4c)} = 0.00563792$$

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

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

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

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25907$$

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.25221$$

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.25907$$

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.4444$$

$$f_{ywe2} = 694.4444$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } c_c = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$y_1 = 0.00097781$$

$$sh_1 = 0.003129$$

$$ft_1 = 325.9374$$

$$fy_1 = 271.6145$$

$$su1 = 0.003129$$

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

$$lo/lou,min = lb/l_d = 0.17502824$$

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

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 $\text{Min}(1, 1.25 * (lb/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs1 = (fs_jacket * A_{sl,ten,jacket} + fs_core * A_{sl,ten,core}) / A_{sl,ten} = 271.6145$$

$$\text{with } Es1 = (Es_jacket * A_{sl,ten,jacket} + Es_core * A_{sl,ten,core}) / A_{sl,ten} = 200000.00$$

$$y2 = 0.00097781$$

$$sh2 = 0.003129$$

$$ft2 = 325.9374$$

$$fy2 = 271.6145$$

$$su2 = 0.003129$$

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

$$lo/lou,min = lb/l_b,min = 0.17502824$$

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

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 $\text{Min}(1, 1.25 * (lb/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs2 = (fs_jacket * A_{sl,com,jacket} + fs_core * A_{sl,com,core}) / A_{sl,com} = 271.6145$$

$$\text{with } Es2 = (Es_jacket * A_{sl,com,jacket} + Es_core * A_{sl,com,core}) / A_{sl,com} = 200000.00$$

$$yv = 0.00097781$$

$$shv = 0.003129$$

$$ftv = 325.9374$$

$$fyv = 271.6145$$

$$suv = 0.003129$$

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

$$lo/lou,min = lb/l_d = 0.17502824$$

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

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

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

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

$$\text{with } fsv = (fs_jacket * A_{sl,mid,jacket} + fs_mid * A_{sl,mid,core}) / A_{sl,mid} = 271.6145$$

$$\text{with } Esv = (Es_jacket * A_{sl,mid,jacket} + Es_mid * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$$

$$1 = A_{sl,ten} / (b * d) * (fs1 / fc) = 0.02330074$$

$$2 = A_{sl,com} / (b * d) * (fs2 / fc) = 0.04154956$$

$$v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.01319688$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 34.07072$$

$$cc (5A.5, TBDY) = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$1 = A_{sl,ten} / (b * d) * (fs1 / fc) = 0.02879016$$

$$2 = A_{sl,com} / (b * d) * (fs2 / fc) = 0.0513382$$

$$v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.01630593$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

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

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$$su (4.9) = 0.18757351$$

$$\mu_u = MRc (4.14) = 1.1683E+008$$

$$u = su (4.1) = 6.1426221E-006$$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.17502824$

$l_b = 300.00$

$l_d = 1714.009$

Calculation of l_b, \min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

l_d, \min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$= 1$

$d_b = 15.23077$

Mean strength value of all re-bars: $f_y = 694.4444$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$c_b = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

Calculation of μ_{u1}

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

$\mu_u = 6.3198187E-006$

$\mu_u = 2.2533E+008$

with full section properties:

$b = 400.00$

$d = 627.00$

$d' = 43.00$

$v = 0.00027032$

$N = 2237.255$

$f_c = 33.00$

α (5A.5, TBDY) = 0.002

Final value of μ_u : $\mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, \mu_c) = 0.00650344$

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

From (5.4b), TBDY: $\mu_u = 0.00650344$

w_e (5.4c) = 0.00563792

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

$a_{se1} = 0.14776895$

$b_{o1} = 340.00$

$h_{o1} = 610.00$

$b_{i21} = 975400.00$

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

$b_{o2} = 192.00$

$h_{o2} = 492.00$

$b_{i22} = 557856.00$

$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25907$

$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.25221$

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

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

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

$h_1 = 670.00$

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

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

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

$h_2 = 500.00$

$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.25907$

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

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

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

$h_1 = 400.00$

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

Ash2 = Astir₂*ns₂ = 100.531
No stirups, ns₂ = 2.00
h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.4444

fywe2 = 694.4444

fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00232446

c = confinement factor = 1.03245

y1 = 0.00097781

sh1 = 0.003129

ft1 = 325.9374

fy1 = 271.6145

su1 = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.17502824

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

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

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

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

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 271.6145

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

y2 = 0.00097781

sh2 = 0.003129

ft2 = 325.9374

fy2 = 271.6145

su2 = 0.003129

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

lo/lou,min = lb/lb,min = 0.17502824

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 = 271.6145

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

yv = 0.00097781

shv = 0.003129

ftv = 325.9374

fyv = 271.6145

suv = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.17502824

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

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

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,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 = 271.6145

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

1 = Asl,ten/(b*d)*(fs1/fc) = 0.04154956

2 = Asl,com/(b*d)*(fs2/fc) = 0.02330074

v = Asl,mid/(b*d)*(fsv/fc) = 0.01319688

and confined core properties:

b = 340.00

d = 597.00

$d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 34.07072$
 $cc (5A.5, TBDY) = 0.00232446$
 $c = \text{confinement factor} = 1.03245$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.0513382$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.02879016$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.01630593$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

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

$su (4.9) = 0.21035251$
 $Mu = MRc (4.14) = 2.2533E+008$
 $u = su (4.1) = 6.3198187E-006$

 Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.17502824$
 $l_b = 300.00$
 $l_d = 1714.009$

Calculation of l_b, min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 l_d, min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$

$db = 15.23077$
 Mean strength value of all re-bars: $f_y = 694.4444$
 $t = 1.16154$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.64216$
 $n = 13.00$

 Calculation of Mu_{2+}

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

$u = 6.1426221E-006$
 $Mu = 1.1683E+008$

 with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.00027032$
 $N = 2237.255$
 $f_c = 33.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00650344$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.00650344$
 $w_e (5.4c) = 0.00563792$
 $ase ((5.4d), TBDY) = (ase1*A_{ext} + ase2*A_{int})/A_{sec} = 0.14776895$
 $ase1 = 0.14776895$
 $bo_1 = 340.00$
 $ho_1 = 610.00$
 $bi2_1 = 975400.00$
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi2_2 = 557856.00$
 $psh, \text{min} * F_{ywe} = \text{Min}(psh, x * F_{ywe}, psh, y * F_{ywe}) = 1.25907$

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.25221
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.25907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.4444

fywe2 = 694.4444

fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00232446

c = confinement factor = 1.03245

y1 = 0.00097781

sh1 = 0.003129

ft1 = 325.9374

fy1 = 271.6145

su1 = 0.003129

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

lo/lou,min = lb/lb = 0.17502824

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 $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 271.6145

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

y2 = 0.00097781

sh2 = 0.003129

ft2 = 325.9374

fy2 = 271.6145

su2 = 0.003129

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

lo/lou,min = lb/lb,min = 0.17502824

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 $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 271.6145

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

yv = 0.00097781

shv = 0.003129

ftv = 325.9374

fyv = 271.6145

suv = 0.003129

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

Shear_factor = 1.00

lo/lou,min = lb/ld = 0.17502824

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

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

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

For calculation of esuv_nominal and yv, shv,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 = (fsjacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 271.6145

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

1 = Asl,ten/(b*d)*(fs1/fc) = 0.02330074

2 = Asl,com/(b*d)*(fs2/fc) = 0.04154956

v = Asl,mid/(b*d)*(fsv/fc) = 0.01319688

and confined core properties:

b = 340.00

d = 597.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07072

cc (5A.5, TBDY) = 0.00232446

c = confinement factor = 1.03245

1 = Asl,ten/(b*d)*(fs1/fc) = 0.02879016

2 = Asl,com/(b*d)*(fs2/fc) = 0.0513382

v = Asl,mid/(b*d)*(fsv/fc) = 0.01630593

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

---->

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

---->

su (4.9) = 0.18757351

Mu = MRc (4.14) = 1.1683E+008

u = su (4.1) = 6.1426221E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.17502824

lb = 300.00

ld = 1714.009

Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

db = 15.23077

Mean strength value of all re-bars: fy = 694.4444

t = 1.16154

s = 0.80

e = 1.00

cb = 25.00

Ktr = 2.64216

n = 13.00

Calculation of Mu2-

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

u = 6.3198187E-006

Mu = 2.2533E+008

with full section properties:

b = 400.00

d = 627.00

d' = 43.00

v = 0.00027032

N = 2237.255

fc = 33.00

co (5A.5, TBDY) = 0.002

Final value of cu: $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00650344$

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

From (5.4b), TBDY: $cu = 0.00650344$

we (5.4c) = 0.00563792

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

ase1 = 0.14776895

bo_1 = 340.00

ho_1 = 610.00

bi2_1 = 975400.00

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

bo_2 = 192.00

ho_2 = 492.00

bi2_2 = 557856.00

$psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.25907$

 $psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.25221$

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

Ash1 = $A_{stir_1} * ns_1 = 157.0796$

No stirups, $ns_1 = 2.00$

h1 = 670.00

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

Ash2 = $A_{stir_2} * ns_2 = 100.531$

No stirups, $ns_2 = 2.00$

h2 = 500.00

 $psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.25907$

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

Ash1 = $A_{stir_1} * ns_1 = 157.0796$

No stirups, $ns_1 = 2.00$

h1 = 400.00

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

Ash2 = $A_{stir_2} * ns_2 = 100.531$

No stirups, $ns_2 = 2.00$

h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.4444

fywe2 = 694.4444

fce = 33.00

From ((5.A5), TBDY), TBDY: $cc = 0.00232446$

c = confinement factor = 1.03245

y1 = 0.00097781

sh1 = 0.003129

ft1 = 325.9374

fy1 = 271.6145

su1 = 0.003129

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

lo/lou,min = $lb / ld = 0.17502824$

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 $fs1 = (fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 271.6145$

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

y2 = 0.00097781

sh2 = 0.003129

ft2 = 325.9374

fy2 = 271.6145

su2 = 0.003129

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

Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.17502824

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 = 271.6145

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

yv = 0.00097781

shv = 0.003129

ftv = 325.9374

fyv = 271.6145

suv = 0.003129

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

lo/lou,min = lb/ld = 0.17502824

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

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

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

For calculation of esuv_nominal and yv, shv,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 = 271.6145

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

1 = Asl,ten/(b*d)*(fs1/fc) = 0.04154956

2 = Asl,com/(b*d)*(fs2/fc) = 0.02330074

v = Asl,mid/(b*d)*(fsv/fc) = 0.01319688

and confined core properties:

b = 340.00

d = 597.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07072

cc (5A.5, TBDY) = 0.00232446

c = confinement factor = 1.03245

1 = Asl,ten/(b*d)*(fs1/fc) = 0.0513382

2 = Asl,com/(b*d)*(fs2/fc) = 0.02879016

v = Asl,mid/(b*d)*(fsv/fc) = 0.01630593

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

su (4.9) = 0.21035251

Mu = MRc (4.14) = 2.2533E+008

u = su (4.1) = 6.3198187E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.17502824

lb = 300.00

ld = 1714.009

Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

db = 15.23077

Mean strength value of all re-bars: fy = 694.4444

t = 1.16154

s = 0.80

e = 1.00

cb = 25.00

Ktr = 2.64216

n = 13.00

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 558197.326$

Calculation of Shear Strength at edge 1, $V_{r1} = 558197.326$
 $V_{r1} = V_n$ ((22.5.1.1), ACI 318-14)

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

From Table (22.5.5.1), ACI 318-14: $V_c = 209131.476$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_c \text{ jacket} * \text{Area jacket} + f'_c \text{ core} * \text{Area core}) / \text{Area section} = 33.00$, but $f_c^{0.5} \leq 8.3$
MPa (22.5.3.1, ACI 318-14)
 $p_w = A_s / (b_w * d) = 0.00331157$
As (tension reinf.) = 709.9999
bw = 400.00
d = 536.00
 $V_u * d / \mu < 1 = 1.00$
 $\mu = 1.0197E+006$
Vu = 9840.633
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 349065.85$
 $V_{s1} = 311832.16$ is calculated for jacket, with:
d = 536.00
Av = 157079.633
fy = 555.5556
s = 150.00
Vs1 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 37233.691$ is calculated for jacket, with:
d2 = 400.00
Av = 100530.965
fy = 555.5556
s = 300.00
Vs2 has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f \leq 818179.336$

Calculation of Shear Strength at edge 2, $V_{r2} = 558197.326$
 $V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

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

From Table (22.5.5.1), ACI 318-14: $V_c = 209131.476$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_c \text{ jacket} * \text{Area jacket} + f'_c \text{ core} * \text{Area core}) / \text{Area section} = 33.00$, but $f_c^{0.5} \leq 8.3$
MPa (22.5.3.1, ACI 318-14)
 $p_w = A_s / (b_w * d) = 0.00331157$
As (tension reinf.) = 709.9999
bw = 400.00
d = 536.00
 $V_u * d / \mu < 1 = 1.00$
 $\mu = 1.0197E+006$
Vu = 9840.633
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 349065.85$
 $V_{s1} = 311832.16$ is calculated for jacket, with:
d = 536.00
Av = 157079.633
fy = 555.5556
s = 150.00
Vs1 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 37233.691$ is calculated for jacket, with:
d = 400.00
Av = 100530.965
fy = 555.5556
s = 300.00

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

2(1-s/d) = 0.50

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

From (11-11), ACI 440: Vs + Vf <= 818179.336

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

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

Constant Properties

Knowledge Factor, = 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 = 555.5556

Concrete Elasticity, Ec = 26999.444

Steel Elasticity, Es = 200000.00

Existing Column

New material of Secondary Member: Concrete Strength, fc = fcm = 33.00

New material of Secondary Member: Steel Strength, fs = fsm = 555.5556

Concrete Elasticity, Ec = 26999.444

Steel Elasticity, Es = 200000.00

#####

Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

New material: Steel Strength, fs = 1.25*fsm = 694.4444

Existing Column

New material: Steel Strength, fs = 1.25*fsm = 694.4444

#####

External Height, H = 670.00

External Width, W = 400.00

Internal Height, H = 500.00

Internal Width, W = 200.00

Cover Thickness, c = 25.00

Mean Confinement Factor overall section = 1.03245

Element Length, L = 3000.00

Secondary Member

Smooth Bars

Ductile Steel

With Detailing for Earthquake Resistance (including stirrups closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length lo = 300.00

No FRP Wrapping

Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force, Va = -2.6375953E-014

EDGE -B-

Shear Force, Vb = 2.6375953E-014

BOTH EDGES

Axial Force, F = -2237.255

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: Aslt = 709.9999

-Compression: Asc = 1668.186

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $Asl,ten = 911.0619$

-Compression: $Asl,com = 911.0619$

-Middle: $Asl,mid = 556.0619$

Calculation of Shear Capacity ratio , $Ve/Vr = 0.15892241$

Member Controlled by Flexure ($Ve/Vr < 1$)

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $Ve = (Mpr1 + Mpr2)/ln \pm wu*ln/2 = 60903.823$

with

$Mpr1 = \text{Max}(Mu1+, Mu1-) = 9.1356E+007$

$Mu1+ = 9.1356E+007$, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination

$Mu1- = 9.1356E+007$, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination

$Mpr2 = \text{Max}(Mu2+, Mu2-) = 9.1356E+007$

$Mu2+ = 9.1356E+007$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination

$Mu2- = 9.1356E+007$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

and

$\pm wu*ln = (|V1| + |V2|)/2$

with

$V1 = -2.6375953E-014$, is the shear force acting at edge 1 for the the static loading combination

$V2 = 2.6375953E-014$, is the shear force acting at edge 2 for the the static loading combination

Calculation of $Mu1+$

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

$u = 1.1029765E-005$

$Mu = 9.1356E+007$

with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.00028344$

$N = 2237.255$

$fc = 33.00$

co (5A.5, TBDY) = 0.002

Final value of cu : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00650344$

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

From (5.4b), TBDY: $cu = 0.00650344$

we (5.4c) = 0.00563792

ase ((5.4d), TBDY) = $(ase1*Aext+ase2*Aint)/Asec = 0.14776895$

$ase1 = 0.14776895$

$bo_1 = 340.00$

$ho_1 = 610.00$

$bi2_1 = 975400.00$

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

$bo_2 = 192.00$

$ho_2 = 492.00$

$bi2_2 = 557856.00$

$psh,min*Fywe = \text{Min}(psh,x*Fywe, psh,y*Fywe) = 1.25907$

$psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.25221$

$ps1$ (external) = $(Ash1*h1/s1)/Asec = 0.00261799$

$Ash1 = Astir_1*ns_1 = 157.0796$

No stirups, $ns_1 = 2.00$

$h1 = 670.00$

$ps2$ (internal) = $(Ash2*h2/s2)/Asec = 0.00062519$

$Ash2 = Astir_2*ns_2 = 100.531$

No stirups, ns₂ = 2.00
h₂ = 500.00

psh_y*Fywe = psh₁*Fywe₁+ps₂*Fywe₂ = 1.25907
ps₁ (external) = (Ash₁*h₁/s₁)/Asec = 0.00156298
Ash₁ = Astir₁*ns₁ = 157.0796
No stirups, ns₁ = 2.00
h₁ = 400.00
ps₂ (internal) = (Ash₂*h₂/s₂)/Asec = 0.00025008
Ash₂ = Astir₂*ns₂ = 100.531
No stirups, ns₂ = 2.00
h₂ = 200.00

Asec = 268000.00

s₁ = 150.00

s₂ = 300.00

fywe₁ = 694.4444

fywe₂ = 694.4444

fce = 33.00

From ((5.A.5), TBDY), TBDY: cc = 0.00232446

c = confinement factor = 1.03245

y₁ = 0.00097781

sh₁ = 0.003129

ft₁ = 325.9374

fy₁ = 271.6145

su₁ = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.17502824

su₁ = 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 y₁, sh₁,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/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} = 271.6145

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

y₂ = 0.00097781

sh₂ = 0.003129

ft₂ = 325.9374

fy₂ = 271.6145

su₂ = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with 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} = 0.17502824

su₂ = 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 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/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} = 271.6145

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

y_v = 0.00097781

sh_v = 0.003129

ft_v = 325.9374

fy_v = 271.6145

suv = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.17502824

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

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

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

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

with $fsv = (fs_{jacket} \cdot Asl_{mid,jacket} + fs_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 271.6145$

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

$1 = Asl_{ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.03135046$

$2 = Asl_{com} / (b \cdot d) \cdot (fs_2 / fc) = 0.03135046$

$v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.01913459$

and confined core properties:

$b = 610.00$

$d = 327.00$

$d' = 13.00$

fcc (5A.2, TBDY) = 34.07072

cc (5A.5, TBDY) = 0.00232446

c = confinement factor = 1.03245

$1 = Asl_{ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.0375932$

$2 = Asl_{com} / (b \cdot d) \cdot (fs_2 / fc) = 0.0375932$

$v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.02294481$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

su (4.9) = 0.20535904

$Mu = MRc$ (4.14) = 9.1356E+007

$u = su$ (4.1) = 1.1029765E-005

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.17502824$

$lb = 300.00$

$ld = 1714.009$

Calculation of lb_{min} according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

ld_{min} from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

$db = 15.23077$

Mean strength value of all re-bars: $fy = 694.4444$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

Calculation of Mu_1 -

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

$u = 1.1029765E-005$

$Mu = 9.1356E+007$

with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.00028344$

$N = 2237.255$

$fc = 33.00$

co (5A.5, TBDY) = 0.002

Final value of cu : $cu^* = \text{shear_factor} \cdot \text{Max}(cu, cc) = 0.00650344$

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

From (5.4b), TBDY: $cu = 0.00650344$

we (5.4c) = 0.00563792

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

$ase_1 = 0.14776895$

bo_1 = 340.00
ho_1 = 610.00
bi2_1 = 975400.00
ase2 = Max(ase1,ase2) = 0.14776895
bo_2 = 192.00
ho_2 = 492.00
bi2_2 = 557856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.25907

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.25221
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.25907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 268000.00
s1 = 150.00
s2 = 300.00
fywe1 = 694.4444
fywe2 = 694.4444
fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00232446
c = confinement factor = 1.03245

y1 = 0.00097781
sh1 = 0.003129
ft1 = 325.9374
fy1 = 271.6145
su1 = 0.003129

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

lo/lou,min = lb/lb,min = 0.17502824

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,min)^ 2/3), from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 271.6145

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

y2 = 0.00097781
sh2 = 0.003129
ft2 = 325.9374
fy2 = 271.6145
su2 = 0.003129

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

lo/lou,min = lb/lb,min = 0.17502824

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,min)^ 2/3), from 10.3.5, ASCE 41-17.

with $fs_2 = (fs_{jacket} \cdot Asl_{com,jacket} + fs_{core} \cdot Asl_{com,core}) / Asl_{com} = 271.6145$
 with $Es_2 = (Es_{jacket} \cdot Asl_{com,jacket} + Es_{core} \cdot Asl_{com,core}) / Asl_{com} = 200000.00$
 $yv = 0.00097781$
 $shv = 0.003129$
 $ftv = 325.9374$
 $fyv = 271.6145$
 $suv = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou,min = lb/ld = 0.17502824$
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$
 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.
 y_1, sh_1,ft_1,fy_1 , are also multiplied by $Min(1,1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs_{jacket} \cdot Asl_{mid,jacket} + fs_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 271.6145$
 with $Esv = (Es_{jacket} \cdot Asl_{mid,jacket} + Es_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 200000.00$
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.03135046$
 $2 = Asl_{com} / (b \cdot d) \cdot (fs_2 / fc) = 0.03135046$
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.01913459$

and confined core properties:

$b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 34.07072$
 $cc (5A.5, TBDY) = 0.00232446$
 $c = \text{confinement factor} = 1.03245$
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.0375932$
 $2 = Asl_{com} / (b \cdot d) \cdot (fs_2 / fc) = 0.0375932$
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.02294481$

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

--->
 $v < vs,y_2$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.20535904$
 $Mu = MRc (4.14) = 9.1356E+007$
 $u = su (4.1) = 1.1029765E-005$

 Calculation of ratio lb/ld

 Lap Length: $lb/ld = 0.17502824$

$lb = 300.00$
 $ld = 1714.009$

Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$= 1$
 $db = 15.23077$
 Mean strength value of all re-bars: $fy = 694.4444$
 $t = 1.16154$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $Ktr = 2.64216$
 $n = 13.00$

 Calculation of Mu_{2+}

 Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 1.1029765E-005$

Mu = 9.1356E+007

with full section properties:

b = 670.00

d = 357.00

d' = 43.00

v = 0.00028344

N = 2237.255

fc = 33.00

co (5A.5, TBDY) = 0.002

Final value of cu: $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00650344$

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

From (5.4b), TBDY: $cu = 0.00650344$

we (5.4c) = 0.00563792

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

ase1 = 0.14776895

bo_1 = 340.00

ho_1 = 610.00

bi2_1 = 975400.00

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

bo_2 = 192.00

ho_2 = 492.00

bi2_2 = 557856.00

$psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.25907$

$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.25221$

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

Ash1 = $A_{stir_1} * ns_1 = 157.0796$

No stirups, $ns_1 = 2.00$

h1 = 670.00

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

Ash2 = $A_{stir_2} * ns_2 = 100.531$

No stirups, $ns_2 = 2.00$

h2 = 500.00

$psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.25907$

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

Ash1 = $A_{stir_1} * ns_1 = 157.0796$

No stirups, $ns_1 = 2.00$

h1 = 400.00

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

Ash2 = $A_{stir_2} * ns_2 = 100.531$

No stirups, $ns_2 = 2.00$

h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.4444

fywe2 = 694.4444

fce = 33.00

From ((5.A.5), TBDY), TBDY: $cc = 0.00232446$

c = confinement factor = 1.03245

y1 = 0.00097781

sh1 = 0.003129

ft1 = 325.9374

fy1 = 271.6145

su1 = 0.003129

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

lo/lou,min = $lb/d = 0.17502824$

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 $\text{Min}(1, 1.25 * (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs1 = (fs_{jacket} \cdot Asl_{ten,jacket} + fs_{core} \cdot Asl_{ten,core}) / Asl_{ten} = 271.6145$
 with $Es1 = (Es_{jacket} \cdot Asl_{ten,jacket} + Es_{core} \cdot Asl_{ten,core}) / Asl_{ten} = 200000.00$
 $y2 = 0.00097781$
 $sh2 = 0.003129$
 $ft2 = 325.9374$
 $fy2 = 271.6145$
 $su2 = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou,min = lb/lb,min = 0.17502824$
 $su2 = 0.4 \cdot esu2_{nominal} ((5.5), TBDY) = 0.032$
 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 $fs2 = (fs_{jacket} \cdot Asl_{com,jacket} + fs_{core} \cdot Asl_{com,core}) / Asl_{com} = 271.6145$
 with $Es2 = (Es_{jacket} \cdot Asl_{com,jacket} + Es_{core} \cdot Asl_{com,core}) / Asl_{com} = 200000.00$
 $yv = 0.00097781$
 $shv = 0.003129$
 $ftv = 325.9374$
 $fyv = 271.6145$
 $suv = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou,min = lb/ld = 0.17502824$
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$
 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 $fsv = (fs_{jacket} \cdot Asl_{mid,jacket} + fs_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 271.6145$
 with $Esv = (Es_{jacket} \cdot Asl_{mid,jacket} + Es_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 200000.00$
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.03135046$
 $2 = Asl_{com} / (b \cdot d) \cdot (fs2 / fc) = 0.03135046$
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.01913459$

and confined core properties:

$b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 34.07072$
 $cc (5A.5, TBDY) = 0.00232446$
 $c = \text{confinement factor} = 1.03245$
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.0375932$
 $2 = Asl_{com} / (b \cdot d) \cdot (fs2 / fc) = 0.0375932$
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.02294481$

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

--->
 $v < vs, y2$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.20535904$
 $Mu = MRc (4.14) = 9.1356E+007$
 $u = su (4.1) = 1.1029765E-005$

 Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.17502824$

$lb = 300.00$
 $ld = 1714.009$

Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 15.23077$

Mean strength value of all re-bars: $f_y = 694.4444$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$cb = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of μ_2 -

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

$$u = 1.1029765E-005$$

$$\mu = 9.1356E+007$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } \mu: \mu^* = \text{shear_factor} * \text{Max}(\mu_c, \mu_{cc}) = 0.00650344$$

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

$$\text{From (5.4b), TBDY: } \mu_c = 0.00650344$$

$$\mu_{cc} (5.4c) = 0.00563792$$

$$\text{ase} ((5.4d), \text{TBDY}) = (\text{ase}_1 * A_{ext} + \text{ase}_2 * A_{int}) / A_{sec} = 0.14776895$$

$$\text{ase}_1 = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i_1} = 975400.00$$

$$\text{ase}_2 = \text{Max}(\text{ase}_1, \text{ase}_2) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i_2} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25907$$

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.25221$$

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.25907$$

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.4444$$

$$f_{ywe2} = 694.4444$$

$$f_{ce} = 33.00$$

From ((5.A.5), TBDY), TBDY: $cc = 0.00232446$
 $c = \text{confinement factor} = 1.03245$

$y1 = 0.00097781$

$sh1 = 0.003129$

$ft1 = 325.9374$

$fy1 = 271.6145$

$su1 = 0.003129$

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

$lo/lou,min = lb/d = 0.17502824$

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

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 $\text{Min}(1, 1.25 * (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs1 = (fs,jacket * Asl,ten,jacket + fs,core * Asl,ten,core) / Asl,ten = 271.6145$

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

$y2 = 0.00097781$

$sh2 = 0.003129$

$ft2 = 325.9374$

$fy2 = 271.6145$

$su2 = 0.003129$

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

$lo/lou,min = lb/lb,min = 0.17502824$

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

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 $\text{Min}(1, 1.25 * (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs2 = (fs,jacket * Asl,com,jacket + fs,core * Asl,com,core) / Asl,com = 271.6145$

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

$yv = 0.00097781$

$shv = 0.003129$

$ftv = 325.9374$

$fyv = 271.6145$

$suv = 0.003129$

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

$lo/lou,min = lb/d = 0.17502824$

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

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

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

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

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

with $fsv = (fs,jacket * Asl,mid,jacket + fs,mid * Asl,mid,core) / Asl,mid = 271.6145$

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

$1 = Asl,ten / (b * d) * (fs1 / fc) = 0.03135046$

$2 = Asl,com / (b * d) * (fs2 / fc) = 0.03135046$

$v = Asl,mid / (b * d) * (fsv / fc) = 0.01913459$

and confined core properties:

$b = 610.00$

$d = 327.00$

$d' = 13.00$

$fcc (5A.2, TBDY) = 34.07072$

$cc (5A.5, TBDY) = 0.00232446$

$c = \text{confinement factor} = 1.03245$

$1 = Asl,ten / (b * d) * (fs1 / fc) = 0.0375932$

$2 = Asl,com / (b * d) * (fs2 / fc) = 0.0375932$

$v = Asl,mid / (b * d) * (fsv / fc) = 0.02294481$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_s, y_2$ - LHS eq.(4.5) is satisfied

--->

$$s_u(4.9) = 0.20535904$$

$$M_u = M_{Rc}(4.14) = 9.1356E+007$$

$$u = s_u(4.1) = 1.1029765E-005$$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.17502824$

$$l_b = 300.00$$

$$l_d = 1714.009$$

Calculation of l_b, \min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

l_d, \min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$d_b = 15.23077$$

Mean strength value of all re-bars: $f_y = 694.4444$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of Shear Strength $V_r = \min(V_{r1}, V_{r2}) = 383229.931$

Calculation of Shear Strength at edge 1, $V_{r1} = 383229.931$

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

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

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

From Table (22.5.5.1), ACI 318-14: $V_c = 197061.477$

= 1 (normal-weight concrete)

Mean concrete strength: $f'_c = (f'_c \text{ jacket} * \text{Area jacket} + f'_c \text{ core} * \text{Area core}) / \text{Area section} = 33.00$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

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

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

$$b_w = 670.00$$

$$d = 320.00$$

$$V_u * d / M_u < 1 = 0.00$$

$$M_u = 2.6257021E-011$$

$$V_u = 2.6375953E-014$$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 186168.454$

$V_{s1} = 186168.454$ is calculated for jacket, with:

$$d = 320.00$$

$$A_v = 157079.633$$

$$f_y = 555.5556$$

$$s = 150.00$$

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

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

$$d_2 = 160.00$$

$$A_v = 100530.965$$

$$f_y = 555.5556$$

$$s = 300.00$$

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

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

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 818179.336$$

Calculation of Shear Strength at edge 2, $V_{r2} = 383229.931$

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

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

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

From Table (22.5.5.1), ACI 318-14: $V_c = 197061.477$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot Area_jacket + f'_{c_core} \cdot Area_core) / Area_section = 33.00$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 670.00$
 $d = 320.00$
 $V_u \cdot d / \mu_u < 1 = 0.00$
 $\mu_u = 5.2870952E-011$
 $V_u = 2.6375953E-014$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 186168.454$
 $V_{s1} = 186168.454$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 555.5556$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 0.00$ is calculated for jacket, with:
 $d = 160.00$
 $A_v = 100530.965$
 $f_y = 555.5556$
 $s = 300.00$
 V_{s2} is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)
 V_f ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f \leq 818179.336$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1
At local axis: 2

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

Constant Properties

Knowledge Factor, = 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, $f_s = f_{sm} = 555.5556$
Concrete Elasticity, $E_c = 26999.444$
Steel Elasticity, $E_s = 200000.00$
Existing Column
New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.5556$
Concrete Elasticity, $E_c = 26999.444$
Steel Elasticity, $E_s = 200000.00$
External Height, $H = 670.00$
External Width, $W = 400.00$
Internal Height, $H = 500.00$
Internal Width, $W = 200.00$
Cover Thickness, $c = 25.00$
Element Length, $L = 3000.00$
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length $l_b = 300.00$

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 1.1047E+007$

Shear Force, $V2 = 1.0300085E-013$

Shear Force, $V3 = 859.7817$

Axial Force, $F = -4363.489$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 709.9999$

-Compression: $As_c = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

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

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

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

Longitudinal External Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten,jacket} = 402.1239$

-Compression: $As_{c,com,jacket} = 804.2477$

-Middle: $As_{c,mid,jacket} = 402.1239$

Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten,core} = 307.8761$

-Compression: $As_{c,com,core} = 461.8141$

-Middle: $As_{c,mid,core} = 0.00$

Mean Diameter of Tension Reinforcement, $Db_L = 15.00$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = 1.0^*$ $u = 0.01307612$

$u = y + p = 0.01307612$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.00307612$ ((4.29), Biskinis Phd)

$M_y = 1.2490E+008$

$L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 6000.00

From table 10.5, ASCE 41_17: $E_{eff} = 0.3 * E_c * I_g = 8.1204E+013$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

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

$y_{ten} = 2.4693920E-006$

with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25 * f_y * (I_b / I_d)^{2/3}) = 252.1446$

$d = 627.00$

$y = 0.18574202$

$A = 0.0095514$

$B = 0.00410281$

with $pt = 0.00283094$

$pc = 0.00504809$

$p_v = 0.00160336$

$N = 4363.489$

$b = 400.00$

$" = 0.06858054$

$y_{comp} = 1.9036374E-005$

with $f_c = 33.00$

$E_c = 26999.444$

$y = 0.18432314$

$A = 0.00944286$

$B = 0.0040338$

with $E_s = 200000.00$

Calculation of ratio l_b/d

Lap Length: $l_d/d, \min = 0.2187853$

$l_b = 300.00$

$l_d = 1371.207$

Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

l_d, \min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)

$= 1$

$db = 15.23077$

Mean strength value of all re-bars: $f_y = 555.5556$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

- Calculation of p -

From table 10-7: $p = 0.01$

with:

- Condition iv occurred

Beam controlled by inadequate embedment into beam-column joint:
($l_b/d < 1$ and With Lapping in the Vicinity of the End Regions)

- Condition i occurred

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

shear control ratio $V_p/V_o = 0.2867466$

- Transverse Reinforcement: C

- Stirrup Spacing $\leq d/3$

- Low ductility demand, $\gamma < 2$ (table 10-6, ASCE 41-17)

$= 6.1436941E-005$

- Stirrup Spacing $\leq d/2$

$d = d_{\text{external}} = 627.00$

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

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

$V_s = 386299.541$, already given in calculation of shear control ratio

design Shear = 859.7817

- ($\rho' - \rho$)/ $\rho_{\text{bal}} = -0.22420383$

$= A_{st}/(b_w \cdot d) = 0.00283094$

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

$\rho' = A_{sc}/(b_w \cdot d) = 0.00665146$

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

From (B-1), ACI 318-11: $\rho_{\text{bal}} = 0.01704038$

$f_c = (f_{c_jacket} \cdot \text{Area}_{\text{jacket}} + f_{c_core} \cdot \text{Area}_{\text{core}}) / \text{section_area} = 33.00$

$f_y = f_{y_jacket_bars} = 555.5556$

From 10.2.7.3, ACI 318-11: $\beta_1 = 0.65$

From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000 / (87000 + f_y) = c_b/d_t = 0.003 / (0.003 + \beta_1) = 0.51923077$

$\beta_1 = 0.00277778$

- $V / (b_w \cdot d \cdot f_c^{0.5}) = 0.00718666$, NOTE: units in lb & in

$b_w = 400.00$

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

At local axis: 2

Integration Section: (a)

Calculation No. 3

beam B1, Floor 1

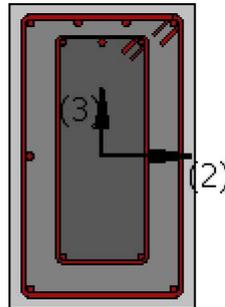
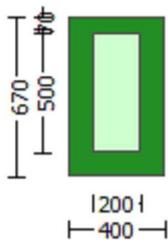
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: Start

Local Axis: (3)



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

At local axis: 3

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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

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, $E_s = 200000.00$

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

With Detailing for Earthquake Resistance (including stirrups closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = l_b = 300.00$
No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 1.1047E+007$

Shear Force, $V_a = 859.7817$

EDGE -B-

Bending Moment, $M_b = 1.5895E+007$

Shear Force, $V_b = 18821.484$

BOTH EDGES

Axial Force, $F = -4363.489$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{st} = 709.9999$

-Compression: $A_{sc} = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

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

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

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

Mean Diameter of Tension Reinforcement, $D_{bL,ten} = 15.00$

New component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = 1.0 \cdot V_n = 486182.769$

V_n ((22.5.1.1), ACI 318-14) = 486182.769

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

From Table (22.5.5.1), ACI 318-14: $V_c = 172023.504$

= 1 (normal-weight concrete)

Mean concrete strength: $f'_c = (f'_{c,jacket} \cdot Area_{jacket} + f'_{c,core} \cdot Area_{core}) / Area_{section} = 25.00$, but $f'_c^{0.5} \leq 8.3$
MPa (22.5.3.1, ACI 318-14)

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

A_s (tension reinf.) = 709.9999

$b_w = 400.00$

$d = 536.00$

$V_u \cdot d / M_u < 1 = 0.04171534$

$M_u = 1.1047E+007$

$V_u = 859.7817$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 314159.265$

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

$d = 536.00$

$A_v = 157079.633$

$f_y = 500.00$

$s = 150.00$

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

$V_{s2} = 33510.322$ is calculated for core, with:

$d = 400.00$

$A_v = 100530.965$

$f_y = 500.00$

$s = 300.00$

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

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

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

From (11-11), ACI 440: $V_s + V_f \leq 712133.705$

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

At local axis: 3

Integration Section: (a)

Calculation No. 4

beam B1, Floor 1

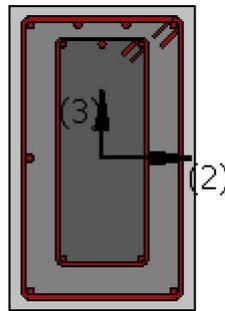
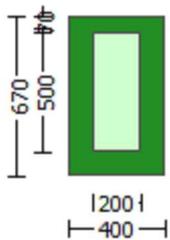
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (θ)

Edge: Start

Local Axis: (3)



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

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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, $f_s = f_{sm} = 555.5556$

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Existing Column

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

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.5556$

Concrete Elasticity, $E_c = 26999.444$

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, $f_s = 1.25 \cdot f_{sm} = 694.4444$

Existing Column

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 694.4444$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$
Mean Confinement Factor overall section = 1.03245
Element Length, $L = 3000.00$
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length $l_o = 300.00$
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, $V_a = 9840.633$
EDGE -B-
Shear Force, $V_b = 9840.633$
BOTH EDGES
Axial Force, $F = -2237.255$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{sl,ten} = 709.9999$
-Compression: $A_{sl,com} = 1668.186$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{sl,ten} = 709.9999$
-Compression: $A_{sl,com} = 1266.062$
-Middle: $A_{sl,mid} = 402.1239$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.2867466$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 160061.187$
with
 $M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 2.2533E+008$
 $Mu_{1+} = 1.1683E+008$, 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
 $Mu_{1-} = 2.2533E+008$, 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
 $M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 2.2533E+008$
 $Mu_{2+} = 1.1683E+008$, 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
 $Mu_{2-} = 2.2533E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination
and
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$
with
 $V_1 = 9840.633$, is the shear force acting at edge 1 for the static loading combination
 $V_2 = 9840.633$, is the shear force acting at edge 2 for the static loading combination

Calculation of Mu_{1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 6.1426221E-006$
 $Mu = 1.1683E+008$

with full section properties:
 $b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.00027032$
 $N = 2237.255$

fc = 33.00

co (5A.5, TBDY) = 0.002

Final value of cu: $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00650344$

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

From (5.4b), TBDY: $cu = 0.00650344$

we (5.4c) = 0.00563792

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

ase1 = 0.14776895

bo_1 = 340.00

ho_1 = 610.00

bi2_1 = 975400.00

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

bo_2 = 192.00

ho_2 = 492.00

bi2_2 = 557856.00

$psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.25907$

$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.25221$

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

Ash1 = $A_{stir_1} * ns_1 = 157.0796$

No stirups, $ns_1 = 2.00$

h1 = 670.00

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

Ash2 = $A_{stir_2} * ns_2 = 100.531$

No stirups, $ns_2 = 2.00$

h2 = 500.00

$psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.25907$

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

Ash1 = $A_{stir_1} * ns_1 = 157.0796$

No stirups, $ns_1 = 2.00$

h1 = 400.00

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

Ash2 = $A_{stir_2} * ns_2 = 100.531$

No stirups, $ns_2 = 2.00$

h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.4444

fywe2 = 694.4444

fce = 33.00

From ((5.A5), TBDY), TBDY: $cc = 0.00232446$

c = confinement factor = 1.03245

y1 = 0.00097781

sh1 = 0.003129

ft1 = 325.9374

fy1 = 271.6145

su1 = 0.003129

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

lo/lou,min = $lb / ld = 0.17502824$

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 $fs1 = (fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 271.6145$

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

y2 = 0.00097781

sh2 = 0.003129

ft2 = 325.9374

fy2 = 271.6145

su2 = 0.003129

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

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.17502824

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 = 271.6145

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

yv = 0.00097781

shv = 0.003129

ftv = 325.9374

fyv = 271.6145

suv = 0.003129

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

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/ld = 0.17502824

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

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

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

For calculation of esuv_nominal and yv, shv,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 = 271.6145

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

1 = Asl,ten/(b*d)*(fs1/fc) = 0.02330074

2 = Asl,com/(b*d)*(fs2/fc) = 0.04154956

v = Asl,mid/(b*d)*(fsv/fc) = 0.01319688

and confined core properties:

b = 340.00

d = 597.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07072

cc (5A.5, TBDY) = 0.00232446

c = confinement factor = 1.03245

1 = Asl,ten/(b*d)*(fs1/fc) = 0.02879016

2 = Asl,com/(b*d)*(fs2/fc) = 0.0513382

v = Asl,mid/(b*d)*(fsv/fc) = 0.01630593

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

su (4.9) = 0.18757351

Mu = MRc (4.14) = 1.1683E+008

u = su (4.1) = 6.1426221E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.17502824

lb = 300.00

ld = 1714.009

Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

db = 15.23077

Mean strength value of all re-bars: fy = 694.4444

t = 1.16154

s = 0.80

e = 1.00

cb = 25.00

Ktr = 2.64216

n = 13.00

Calculation of Mu1-

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

$$\phi_u = 6.3198187E-006$$

$$Mu = 2.2533E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_{cu}: \phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.00650344$$

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

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.00650344$$

$$\phi_{we} \text{ (5.4c)} = 0.00563792$$

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

$$\phi_{ase1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

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

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$\phi_{psh, \min} * F_{ywe} = \text{Min}(\phi_{psh, x} * F_{ywe}, \phi_{psh, y} * F_{ywe}) = 1.25907$$

$$\phi_{psh, x} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{psh2} * F_{ywe2} = 2.25221$$

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

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

No stirrups, $n_{s_1} = 2.00$

$$h_1 = 670.00$$

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

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

No stirrups, $n_{s_2} = 2.00$

$$h_2 = 500.00$$

$$\phi_{psh, y} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{psh2} * F_{ywe2} = 1.25907$$

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

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

No stirrups, $n_{s_1} = 2.00$

$$h_1 = 400.00$$

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

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

No stirrups, $n_{s_2} = 2.00$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.4444$$

$$f_{ywe2} = 694.4444$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_{cc} = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$y_1 = 0.00097781$$

$$sh_1 = 0.003129$$

$$ft_1 = 325.9374$$

$$fy_1 = 271.6145$$

$$su_1 = 0.003129$$

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

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/ld = 0.17502824

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 $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 271.6145

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

y2 = 0.00097781

sh2 = 0.003129

ft2 = 325.9374

fy2 = 271.6145

su2 = 0.003129

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

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.17502824

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 $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 271.6145

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

yv = 0.00097781

shv = 0.003129

ftv = 325.9374

fyv = 271.6145

suv = 0.003129

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

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/ld = 0.17502824

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

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

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

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

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

with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 271.6145

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

1 = Asl,ten/(b*d)*(fs1/fc) = 0.04154956

2 = Asl,com/(b*d)*(fs2/fc) = 0.02330074

v = Asl,mid/(b*d)*(fsv/fc) = 0.01319688

and confined core properties:

b = 340.00

d = 597.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07072

cc (5A.5, TBDY) = 0.00232446

c = confinement factor = 1.03245

1 = Asl,ten/(b*d)*(fs1/fc) = 0.0513382

2 = Asl,com/(b*d)*(fs2/fc) = 0.02879016

v = Asl,mid/(b*d)*(fsv/fc) = 0.01630593

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

su (4.9) = 0.21035251

Mu = MRc (4.14) = 2.2533E+008

u = su (4.1) = 6.3198187E-006

Calculation of ratio lb/ld

Lap Length: $l_b/l_d = 0.17502824$

$l_b = 300.00$

$l_d = 1714.009$

Calculation of l_b, \min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

l_d, \min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$= 1$

$db = 15.23077$

Mean strength value of all re-bars: $f_y = 694.4444$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

Calculation of μ_{2+}

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

$\mu = 6.1426221E-006$

$\mu = 1.1683E+008$

with full section properties:

$b = 400.00$

$d = 627.00$

$d' = 43.00$

$v = 0.00027032$

$N = 2237.255$

$f_c = 33.00$

α (5A.5, TBDY) = 0.002

Final value of μ : $\mu^* = \text{shear_factor} * \text{Max}(\mu, \alpha) = 0.00650344$

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

From (5.4b), TBDY: $\mu = 0.00650344$

w_e (5.4c) = 0.00563792

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

$a_{se1} = 0.14776895$

$b_{o,1} = 340.00$

$h_{o,1} = 610.00$

$b_{i,2,1} = 975400.00$

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

$b_{o,2} = 192.00$

$h_{o,2} = 492.00$

$b_{i,2,2} = 557856.00$

$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25907$

$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.25221$

ps_1 (external) = $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$

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

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

$h_1 = 670.00$

ps_2 (internal) = $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$

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

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

$h_2 = 500.00$

$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.25907$

ps_1 (external) = $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$

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

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

$h_1 = 400.00$

ps_2 (internal) = $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$

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

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

h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.4444

fywe2 = 694.4444

fce = 33.00

From ((5.A.5), TBDY), TBDY: cc = 0.00232446

c = confinement factor = 1.03245

y1 = 0.00097781

sh1 = 0.003129

ft1 = 325.9374

fy1 = 271.6145

su1 = 0.003129

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

lo/lou,min = lb/lb = 0.17502824

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 = 271.6145

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

y2 = 0.00097781

sh2 = 0.003129

ft2 = 325.9374

fy2 = 271.6145

su2 = 0.003129

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

lo/lou,min = lb/lb,min = 0.17502824

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 = 271.6145

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

yv = 0.00097781

shv = 0.003129

ftv = 325.9374

fyv = 271.6145

suv = 0.003129

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

lo/lou,min = lb/lb = 0.17502824

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

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

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,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 = 271.6145

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

1 = Asl,ten/(b*d)*(fs1/fc) = 0.02330074

2 = Asl,com/(b*d)*(fs2/fc) = 0.04154956

v = Asl,mid/(b*d)*(fsv/fc) = 0.01319688

and confined core properties:

b = 340.00

d = 597.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07072

$$cc \text{ (5A.5, TBDY)} = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.02879016$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.0513382$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.01630593$$

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

--->

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

--->

$$su \text{ (4.9)} = 0.18757351$$

$$Mu = MRc \text{ (4.14)} = 1.1683E+008$$

$$u = su \text{ (4.1)} = 6.1426221E-006$$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.17502824$

$$l_b = 300.00$$

$$l_d = 1714.009$$

Calculation of l_b ,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

l_d ,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$db = 15.23077$$

Mean strength value of all re-bars: $f_y = 694.4444$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$cb = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of Mu_2 -

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

$$u = 6.3198187E-006$$

$$Mu = 2.2533E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } cu: cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00650344$$

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

$$\text{From (5.4b), TBDY: } cu = 0.00650344$$

$$w_e \text{ (5.4c)} = 0.00563792$$

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

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

$$ho_1 = 610.00$$

$$bi2_1 = 975400.00$$

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

$$bo_2 = 192.00$$

$$ho_2 = 492.00$$

$$bi2_2 = 557856.00$$

$$psh_{,min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.25907$$

$$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.25221$$

$$ps1 \text{ (external)} = (A_{sh1} * h1 / s1) / A_{sec} = 0.00261799$$

Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.25907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 268000.00
s1 = 150.00
s2 = 300.00
fywe1 = 694.4444
fywe2 = 694.4444
fce = 33.00

From ((5.A.5), TBDY), TBDY: cc = 0.00232446
c = confinement factor = 1.03245

y1 = 0.00097781
sh1 = 0.003129
ft1 = 325.9374
fy1 = 271.6145
su1 = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.17502824

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/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 = 271.6145

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

y2 = 0.00097781
sh2 = 0.003129
ft2 = 325.9374
fy2 = 271.6145
su2 = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.17502824

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/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 = 271.6145

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

yv = 0.00097781
shv = 0.003129
ftv = 325.9374
fyv = 271.6145
suv = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.17502824

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

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

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

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

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

$$\text{with } fsv = (fs_jacket * Asl_mid_jacket + fs_mid * Asl_mid_core) / Asl_mid = 271.6145$$

$$\text{with } Esv = (Es_jacket * Asl_mid_jacket + Es_mid * Asl_mid_core) / Asl_mid = 200000.00$$

$$1 = Asl_ten / (b * d) * (fs1 / fc) = 0.04154956$$

$$2 = Asl_com / (b * d) * (fs2 / fc) = 0.02330074$$

$$v = Asl_mid / (b * d) * (fsv / fc) = 0.01319688$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 34.07072$$

$$cc (5A.5, TBDY) = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$1 = Asl_ten / (b * d) * (fs1 / fc) = 0.0513382$$

$$2 = Asl_com / (b * d) * (fs2 / fc) = 0.02879016$$

$$v = Asl_mid / (b * d) * (fsv / fc) = 0.01630593$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$$su (4.9) = 0.21035251$$

$$\text{Mu} = \text{MRc} (4.14) = 2.2533\text{E}+008$$

$$u = su (4.1) = 6.3198187\text{E}-006$$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.17502824$

$$lb = 300.00$$

$$ld = 1714.009$$

Calculation of lb, min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

ld, min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$db = 15.23077$$

Mean strength value of all re-bars: $fy = 694.4444$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$cb = 25.00$$

$$Ktr = 2.64216$$

$$n = 13.00$$

Calculation of Shear Strength $Vr = \text{Min}(Vr1, Vr2) = 558197.326$

Calculation of Shear Strength at edge 1, $Vr1 = 558197.326$

$Vr1 = Vn$ ((22.5.1.1), ACI 318-14)

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

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

From Table (22.5.5.1), ACI 318-14: $Vc = 209131.476$

= 1 (normal-weight concrete)

Mean concrete strength: $fc' = (fc'_jacket * Area_jacket + fc'_core * Area_core) / Area_section = 33.00$, but $fc'^{0.5} \leq 8.3$

MPa (22.5.3.1, ACI 318-14)

$$pw = As / (bw * d) = 0.00331157$$

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

$$bw = 400.00$$

$$d = 536.00$$

$$Vu*d/Mu < 1 = 1.00$$

$$Mu = 1.0197E+006$$

$$Vu = 9840.633$$

From (11.5.4.8), ACI 318-14: $Vs1 + Vs2 = 349065.85$

$Vs1 = 311832.16$ is calculated for jacket, with:

$$d = 536.00$$

$$Av = 157079.633$$

$$fy = 555.5556$$

$$s = 150.00$$

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

$Vs2 = 37233.691$ is calculated for jacket, with:

$$d2 = 400.00$$

$$Av = 100530.965$$

$$fy = 555.5556$$

$$s = 300.00$$

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

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

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

$$\text{From (11-11), ACI 440: } Vs + Vf \leq 818179.336$$

Calculation of Shear Strength at edge 2, $Vr2 = 558197.326$

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

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

From Table (22.5.5.1), ACI 318-14: $Vc = 209131.476$

= 1 (normal-weight concrete)

Mean concrete strength: $fc' = (fc'_{\text{jacket}} * Area_{\text{jacket}} + fc'_{\text{core}} * Area_{\text{core}}) / Area_{\text{section}} = 33.00$, but $fc'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$$pw = As / (bw * d) = 0.00331157$$

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

$$bw = 400.00$$

$$d = 536.00$$

$$Vu*d/Mu < 1 = 1.00$$

$$Mu = 1.0197E+006$$

$$Vu = 9840.633$$

From (11.5.4.8), ACI 318-14: $Vs1 + Vs2 = 349065.85$

$Vs1 = 311832.16$ is calculated for jacket, with:

$$d = 536.00$$

$$Av = 157079.633$$

$$fy = 555.5556$$

$$s = 150.00$$

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

$Vs2 = 37233.691$ is calculated for jacket, with:

$$d = 400.00$$

$$Av = 100530.965$$

$$fy = 555.5556$$

$$s = 300.00$$

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

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

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

$$\text{From (11-11), ACI 440: } Vs + Vf \leq 818179.336$$

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

At local axis: 3

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

At Shear local axis: 2

(Bending local axis: 3)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 1.00$
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, $f_s = f_{sm} = 555.5556$
Concrete Elasticity, $E_c = 26999.444$
Steel Elasticity, $E_s = 200000.00$
Existing Column
New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.5556$
Concrete Elasticity, $E_c = 26999.444$
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, $f_s = 1.25 * f_{sm} = 694.4444$
Existing Column
New material: Steel Strength, $f_s = 1.25 * f_{sm} = 694.4444$

External Height, $H = 670.00$
External Width, $W = 400.00$
Internal Height, $H = 500.00$
Internal Width, $W = 200.00$
Cover Thickness, $c = 25.00$
Mean Confinement Factor overall section = 1.03245
Element Length, $L = 3000.00$
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length $l_o = 300.00$
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, $V_a = -2.6375953E-014$
EDGE -B-
Shear Force, $V_b = 2.6375953E-014$
BOTH EDGES
Axial Force, $F = -2237.255$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{st} = 709.9999$
-Compression: $A_{sc} = 1668.186$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{st,ten} = 911.0619$
-Compression: $A_{sc,com} = 911.0619$
-Middle: $A_{sl,mid} = 556.0619$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.15892241$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u * l_n / 2 = 60903.823$
with
 $M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 9.1356E+007$
 $Mu_{1+} = 9.1356E+007$, 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
 $Mu_{1-} = 9.1356E+007$, 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
 $M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 9.1356E+007$

$\mu_{2+} = 9.1356E+007$, 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

$\mu_{2-} = 9.1356E+007$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination
and

$$\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$$

with

$V_1 = -2.6375953E-014$, is the shear force acting at edge 1 for the the static loading combination

$V_2 = 2.6375953E-014$, is the shear force acting at edge 2 for the the static loading combination

Calculation of μ_{1+}

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

$$u = 1.1029765E-005$$

$$\mu = 9.1356E+007$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.00650344$$

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

$$\text{From (5.4b), TBDY: } \phi_u = 0.00650344$$

$$\omega_e \text{ (5.4c)} = 0.00563792$$

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

$$a_{se1} = 0.14776895$$

$$b_{o1} = 340.00$$

$$h_{o1} = 610.00$$

$$b_{i2_1} = 975400.00$$

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

$$b_{o2} = 192.00$$

$$h_{o2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh, \min} \cdot F_{ywe} = \text{Min}(p_{sh, x} \cdot F_{ywe}, p_{sh, y} \cdot F_{ywe}) = 1.25907$$

 $p_{sh, x} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{s2} \cdot F_{ywe2} = 2.25221$

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

$$A_{sh1} = A_{stir_1} \cdot n_{s_1} = 157.0796$$

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

$$h_1 = 670.00$$

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

$$A_{sh2} = A_{stir_2} \cdot n_{s_2} = 100.531$$

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

$$h_2 = 500.00$$

 $p_{sh, y} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{s2} \cdot F_{ywe2} = 1.25907$

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

$$A_{sh1} = A_{stir_1} \cdot n_{s_1} = 157.0796$$

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

$$h_1 = 400.00$$

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

$$A_{sh2} = A_{stir_2} \cdot n_{s_2} = 100.531$$

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

$$h_2 = 200.00$$

 $A_{sec} = 268000.00$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.4444$$

$$f_{ywe2} = 694.4444$$

$f_{ce} = 33.00$
 From ((5.A.5), TBDY), TBDY: $cc = 0.00232446$
 $c = \text{confinement factor} = 1.03245$
 $y_1 = 0.00097781$
 $sh_1 = 0.003129$
 $ft_1 = 325.9374$
 $fy_1 = 271.6145$
 $su_1 = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou, \min = lb/ld = 0.17502824$
 $su_1 = 0.4 * esu_1 \text{ nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_1 \text{ nominal} = 0.08$,
 For calculation of $esu_1 \text{ nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered
 characteristic value $fsy_1 = fs_1/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_1 = (fs_{jacket} * Asl, \text{ten}, \text{jacket} + fs_{core} * Asl, \text{ten}, \text{core}) / Asl, \text{ten} = 271.6145$
 with $Es_1 = (Es_{jacket} * Asl, \text{ten}, \text{jacket} + Es_{core} * Asl, \text{ten}, \text{core}) / Asl, \text{ten} = 200000.00$
 $y_2 = 0.00097781$
 $sh_2 = 0.003129$
 $ft_2 = 325.9374$
 $fy_2 = 271.6145$
 $su_2 = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou, \min = lb/lb, \min = 0.17502824$
 $su_2 = 0.4 * esu_2 \text{ nominal} ((5.5), TBDY) = 0.032$
 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 $fs_2 = (fs_{jacket} * Asl, \text{com}, \text{jacket} + fs_{core} * Asl, \text{com}, \text{core}) / Asl, \text{com} = 271.6145$
 with $Es_2 = (Es_{jacket} * Asl, \text{com}, \text{jacket} + Es_{core} * Asl, \text{com}, \text{core}) / Asl, \text{com} = 200000.00$
 $y_v = 0.00097781$
 $sh_v = 0.003129$
 $ft_v = 325.9374$
 $fy_v = 271.6145$
 $suv = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou, \min = lb/ld = 0.17502824$
 $suv = 0.4 * esuv \text{ nominal} ((5.5), TBDY) = 0.032$
 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 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 $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs_{jacket} * Asl, \text{mid}, \text{jacket} + fs_{mid} * Asl, \text{mid}, \text{core}) / Asl, \text{mid} = 271.6145$
 with $Es_v = (Es_{jacket} * Asl, \text{mid}, \text{jacket} + Es_{mid} * Asl, \text{mid}, \text{core}) / Asl, \text{mid} = 200000.00$
 $1 = Asl, \text{ten} / (b * d) * (fs_1 / fc) = 0.03135046$
 $2 = Asl, \text{com} / (b * d) * (fs_2 / fc) = 0.03135046$
 $v = Asl, \text{mid} / (b * d) * (fsv / fc) = 0.01913459$
 and confined core properties:
 $b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 34.07072$
 $cc (5A.5, TBDY) = 0.00232446$
 $c = \text{confinement factor} = 1.03245$
 $1 = Asl, \text{ten} / (b * d) * (fs_1 / fc) = 0.0375932$
 $2 = Asl, \text{com} / (b * d) * (fs_2 / fc) = 0.0375932$
 $v = Asl, \text{mid} / (b * d) * (fsv / fc) = 0.02294481$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.20535904
Mu = MRc (4.14) = 9.1356E+007
u = su (4.1) = 1.1029765E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.17502824
lb = 300.00
ld = 1714.009
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
= 1
db = 15.23077
Mean strength value of all re-bars: fy = 694.4444
t = 1.16154
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.64216
n = 13.00

Calculation of Mu1-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 1.1029765E-005
Mu = 9.1356E+007

with full section properties:

b = 670.00
d = 357.00
d' = 43.00
v = 0.00028344
N = 2237.255
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00650344
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00650344
we (5.4c) = 0.00563792
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.14776895
ase1 = 0.14776895
bo_1 = 340.00
ho_1 = 610.00
bi_1 = 975400.00
ase2 = Max(ase1,ase2) = 0.14776895
bo_2 = 192.00
ho_2 = 492.00
bi_2 = 557856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.25907

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.25221
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = psh₁*Fywe₁+ps₂*Fywe₂ = 1.25907
ps₁ (external) = (Ash₁*h₁/s₁)/Asec = 0.00156298
Ash₁ = Astir₁*ns₁ = 157.0796
No stirups, ns₁ = 2.00
h₁ = 400.00
ps₂ (internal) = (Ash₂*h₂/s₂)/Asec = 0.00025008
Ash₂ = Astir₂*ns₂ = 100.531
No stirups, ns₂ = 2.00
h₂ = 200.00

Asec = 268000.00

s₁ = 150.00

s₂ = 300.00

fywe₁ = 694.4444

fywe₂ = 694.4444

fce = 33.00

From ((5.A.5), TBDY), TBDY: cc = 0.00232446

c = confinement factor = 1.03245

y₁ = 0.00097781

sh₁ = 0.003129

ft₁ = 325.9374

fy₁ = 271.6145

su₁ = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.17502824

su₁ = 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 y₁, sh₁,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/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} = 271.6145

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

y₂ = 0.00097781

sh₂ = 0.003129

ft₂ = 325.9374

fy₂ = 271.6145

su₂ = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with 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} = 0.17502824

su₂ = 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 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/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} = 271.6145

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

y_v = 0.00097781

sh_v = 0.003129

ft_v = 325.9374

fy_v = 271.6145

suv = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.17502824

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

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

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

y₁, sh₁,ft₁,fy₁, are also multiplied by Min(1,1.25*(lb/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} = 271.6145

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

$$1 = A_{sl,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.03135046$$

$$2 = A_{sl,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.03135046$$

$$v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.01913459$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 34.07072$$

$$c_c (5A.5, TBDY) = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$1 = A_{sl,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.0375932$$

$$2 = A_{sl,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.0375932$$

$$v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.02294481$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$$s_u (4.9) = 0.20535904$$

$$M_u = M_{Rc} (4.14) = 9.1356E+007$$

$$u = s_u (4.1) = 1.1029765E-005$$

Calculation of ratio l_b/d

Lap Length: $l_b/d = 0.17502824$

$$l_b = 300.00$$

$$l_d = 1714.009$$

Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$d_b = 15.23077$$

Mean strength value of all re-bars: $f_y = 694.4444$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of M_{u2+}

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

$$u = 1.1029765E-005$$

$$M_u = 9.1356E+007$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} \cdot \text{Max}(c_u, c_c) = 0.00650344$$

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

$$\text{From (5.4b), TBDY: } c_u = 0.00650344$$

$$w_e (5.4c) = 0.00563792$$

$$\text{ase ((5.4d), TBDY) = } (a_{se1} \cdot A_{ext} + a_{se2} \cdot A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

bi2_1 = 975400.00
ase2 = Max(ase1,ase2) = 0.14776895
bo_2 = 192.00
ho_2 = 492.00
bi2_2 = 557856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.25907

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.25221
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.25907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 268000.00
s1 = 150.00
s2 = 300.00
fywe1 = 694.4444
fywe2 = 694.4444
fce = 33.00

From ((5.A.5), TBDY), TBDY: cc = 0.00232446
c = confinement factor = 1.03245

y1 = 0.00097781
sh1 = 0.003129
ft1 = 325.9374
fy1 = 271.6145
su1 = 0.003129

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

lo/lou,min = lb/lb,min = 0.17502824

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,min)^ 2/3), from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 271.6145

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

y2 = 0.00097781
sh2 = 0.003129
ft2 = 325.9374
fy2 = 271.6145
su2 = 0.003129

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

lo/lou,min = lb/lb,min = 0.17502824

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,min)^ 2/3), from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 271.6145

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

$y_v = 0.000977781$
 $sh_v = 0.003129$
 $ft_v = 325.9374$
 $fy_v = 271.6145$
 $su_v = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lo_{min} = lb/ld = 0.17502824$
 $su_v = 0.4 * esuv_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fs_v = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fs_v = fsv/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs_{jacket} * Asl_{mid,jacket} + fs_{mid} * Asl_{mid,core}) / Asl_{mid} = 271.6145$
 with $Esv = (Es_{jacket} * Asl_{mid,jacket} + Es_{mid} * Asl_{mid,core}) / Asl_{mid} = 200000.00$
 $1 = Asl_{ten} / (b * d) * (fs_1 / fc) = 0.03135046$
 $2 = Asl_{com} / (b * d) * (fs_2 / fc) = 0.03135046$
 $v = Asl_{mid} / (b * d) * (fsv / fc) = 0.01913459$

and confined core properties:

$b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 34.07072$
 $cc (5A.5, TBDY) = 0.00232446$
 $c = \text{confinement factor} = 1.03245$
 $1 = Asl_{ten} / (b * d) * (fs_1 / fc) = 0.0375932$
 $2 = Asl_{com} / (b * d) * (fs_2 / fc) = 0.0375932$
 $v = Asl_{mid} / (b * d) * (fsv / fc) = 0.02294481$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

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

$su (4.9) = 0.20535904$

$Mu = MRc (4.14) = 9.1356E+007$

$u = su (4.1) = 1.1029765E-005$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.17502824$

$lb = 300.00$

$ld = 1714.009$

Calculation of lb_{min} according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

ld_{min} from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$= 1$

$db = 15.23077$

Mean strength value of all re-bars: $fy = 694.4444$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$Ktr = 2.64216$

$n = 13.00$

Calculation of Mu_2 -

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

$u = 1.1029765E-005$

$Mu = 9.1356E+007$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00650344$$

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

$$\text{From (5.4b), TBDY: } c_u = 0.00650344$$

$$w_e (5.4c) = 0.00563792$$

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

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

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

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25907$$

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.25221$$

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.25907$$

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.4444$$

$$f_{ywe2} = 694.4444$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } c_c = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$y_1 = 0.00097781$$

$$sh_1 = 0.003129$$

$$ft_1 = 325.9374$$

$$fy_1 = 271.6145$$

$$su_1 = 0.003129$$

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

$$l_o / l_{ou, \min} = l_b / d = 0.17502824$$

$$su_1 = 0.4 * e_{su1_nominal} ((5.5), TBDY) = 0.032$$

$$\text{From table 5A.1, TBDY: } e_{su1_nominal} = 0.08,$$

For calculation of $e_{su1_nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered characteristic value $f_{sy1} = f_{s1} / 1.2$, from table 5.1, TBDY.

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

$$\text{with } f_{s1} = (f_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + f_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 271.6145$$

$$\text{with } E_{s1} = (E_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + E_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 200000.00$$

y2 = 0.00097781
sh2 = 0.003129
ft2 = 325.9374
fy2 = 271.6145
su2 = 0.003129

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

lo/lou,min = lb/lb,min = 0.17502824

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 = 271.6145

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

yv = 0.00097781
shv = 0.003129

ftv = 325.9374

fyv = 271.6145

suv = 0.003129

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

lo/lou,min = lb/ld = 0.17502824

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

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

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

For calculation of esuv_nominal and yv, shv,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 = 271.6145

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

1 = Asl,ten/(b*d)*(fs1/fc) = 0.03135046

2 = Asl,com/(b*d)*(fs2/fc) = 0.03135046

v = Asl,mid/(b*d)*(fsv/fc) = 0.01913459

and confined core properties:

b = 610.00

d = 327.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07072

cc (5A.5, TBDY) = 0.00232446

c = confinement factor = 1.03245

1 = Asl,ten/(b*d)*(fs1/fc) = 0.0375932

2 = Asl,com/(b*d)*(fs2/fc) = 0.0375932

v = Asl,mid/(b*d)*(fsv/fc) = 0.02294481

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

su (4.9) = 0.20535904

Mu = MRc (4.14) = 9.1356E+007

u = su (4.1) = 1.1029765E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.17502824

lb = 300.00

ld = 1714.009

Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

db = 15.23077

Mean strength value of all re-bars: fy = 694.4444

t = 1.16154

s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.64216
n = 13.00

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 383229.931$

Calculation of Shear Strength at edge 1, $V_{r1} = 383229.931$
 $V_{r1} = V_n$ ((22.5.1.1), ACI 318-14)

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

From Table (22.5.5.1), ACI 318-14: $V_c = 197061.477$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot \text{Area}_{jacket} + f'_{c_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 33.00$, but $f'_c^{0.5} \leq 8.3$
MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 670.00$
 $d = 320.00$
 $V_u \cdot d / \mu < 1 = 0.00$
 $\mu = 2.6257021E-011$
 $V_u = 2.6375953E-014$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 186168.454$
 $V_{s1} = 186168.454$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 555.5556$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 0.00$ is calculated for jacket, with:
 $d_2 = 160.00$
 $A_v = 100530.965$
 $f_y = 555.5556$
 $s = 300.00$
 V_{s2} is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)
 V_f ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f \leq 818179.336$

Calculation of Shear Strength at edge 2, $V_{r2} = 383229.931$
 $V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

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

From Table (22.5.5.1), ACI 318-14: $V_c = 197061.477$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot \text{Area}_{jacket} + f'_{c_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 33.00$, but $f'_c^{0.5} \leq 8.3$
MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 670.00$
 $d = 320.00$
 $V_u \cdot d / \mu < 1 = 0.00$
 $\mu = 5.2870952E-011$
 $V_u = 2.6375953E-014$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 186168.454$
 $V_{s1} = 186168.454$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 555.5556$
 $s = 150.00$

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

Vs2 = 0.00 is calculated for jacket, with:

d = 160.00

Av = 100530.965

fy = 555.5556

s = 300.00

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

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

From (11-11), ACI 440: Vs + Vf <= 818179.336

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

At local axis: 2

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

At local axis: 3

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor, = 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 = 555.5556

Concrete Elasticity, Ec = 26999.444

Steel Elasticity, Es = 200000.00

Existing Column

New material of Secondary Member: Concrete Strength, fc = fcm = 33.00

New material of Secondary Member: Steel Strength, fs = fsm = 555.5556

Concrete Elasticity, Ec = 26999.444

Steel Elasticity, Es = 200000.00

External Height, H = 670.00

External Width, W = 400.00

Internal Height, H = 500.00

Internal Width, W = 200.00

Cover Thickness, c = 25.00

Element Length, L = 3000.00

Secondary Member

Smooth Bars

Ductile Steel

With Detailing for Earthquake Resistance (including stirrups closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length lb = 300.00

No FRP Wrapping

Stepwise Properties

Bending Moment, M = 1.8803257E-010

Shear Force, V2 = 1.0300085E-013

Shear Force, V3 = 859.7817

Axial Force, F = -4363.489

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: Aslt = 709.9999

-Compression: Aslc = 1668.186

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: Asl,ten = 911.0619

-Compression: Asl,com = 911.0619

-Middle: Asl,mid = 556.0619

Longitudinal External Reinforcement Area Distribution (in 3 divisions)

-Tension: Asl,ten,jacket = 603.1858

-Compression: $Asl,com,jacket = 603.1858$

-Middle: $Asl,mid,jacket = 402.1239$

Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)

-Tension: $Asl,ten,core = 307.8761$

-Compression: $Asl,com,core = 307.8761$

-Middle: $Asl,mid,core = 153.938$

Mean Diameter of Tension Reinforcement, $DbL = 15.20$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u,R = 1.0^*$ $u = 0.00656885$

$u = y + p = 0.00656885$

- Calculation of y -

$y = (My*Ls/3)/Eleff = 0.00156885$ ((4.29),Biskinis Phd)

$My = 9.0816E+007$

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

From table 10.5, ASCE 41_17: $Eleff = 0.3*Ec*lg = 2.8943E+013$

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7 -

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

$y_{ten} = 4.5526113E-006$

with ((10.1), ASCE 41-17) $fy = \text{Min}(fy, 1.25*fy*(lb/d)^{2/3}) = 252.1446$

$d = 357.00$

$y = 0.22430531$

$A = 0.01001501$

$B = 0.00564247$

with $pt = 0.00380895$

$pc = 0.00380895$

$pv = 0.00232477$

$N = 4363.489$

$b = 670.00$

" = 0.12044818

$y_{comp} = 2.7617879E-005$

with $fc = 33.00$

$Ec = 26999.444$

$y = 0.22313777$

$A = 0.0099012$

$B = 0.00557012$

with $Es = 200000.00$

Calculation of ratio lb/d

Lap Length: $ld/d,min = 0.2187853$

$lb = 300.00$

$ld = 1371.207$

Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)

= 1

$db = 15.23077$

Mean strength value of all re-bars: $fy = 555.5556$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$Ktr = 2.64216$

$n = 13.00$

- Calculation of ρ -

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

with:

- Condition iv occurred

Beam controlled by inadequate embedment into beam-column joint:
($l_b/d < 1$ and With Lapping in the Vicinity of the End Regions

- Condition i occurred

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

shear control ratio $V_p/V_o = 0.15892241$

- Transverse Reinforcement: NC

- Stirrup Spacing $> d/3$

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

$= 5.7541466E-022$

- Stirrup Spacing $\leq d/2$

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

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

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

$V_s = 215955.406$, already given in calculation of shear control ratio

design Shear = $1.0300085E-013$

- ($\rho - \rho'_{\text{bal}}$) / $\rho_{\text{bal}} = -0.23508642$

$= A_{s1t}/(b_w \cdot d) = 0.00296835$

Tension Reinf Area: $A_{s1t} = 709.9999$

$\rho' = A_{s1c}/(b_w \cdot d) = 0.00697431$

Compression Reinf Area: $A_{s1c} = 1668.186$

From (B-1), ACI 318-11: $\rho_{\text{bal}} = 0.01704038$

$f_c = (f_{c_{\text{jacket}}} \cdot \text{Area}_{\text{jacket}} + f_{c_{\text{core}}} \cdot \text{Area}_{\text{core}}) / \text{section_area} = 33.00$

$f_y = f_{y_{\text{jacket_bars}}} = 555.5556$

From 10.2.7.3, ACI 318-11: $\lambda = 1 = 0.65$

From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000 / (87000 + f_y) = c_b/d_t = 0.003 / (0.003 + \lambda y) = 0.51923077$

$y = 0.00277778$

- $V / (b_w \cdot d \cdot f_c^{0.5}) = 9.0274287E-019$, NOTE: units in lb & in

$b_w = 670.00$

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

At local axis: 3

Integration Section: (a)

Calculation No. 5

beam B1, Floor 1

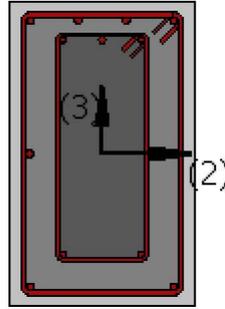
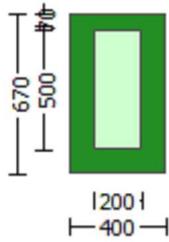
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: End

Local Axis: (2)



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

At local axis: 2

Integration Section: (b)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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

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, $E_s = 200000.00$

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

With Detailing for Earthquake Resistance (including stirrups closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = l_b = 300.00$

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 1.8803257E-010$

Shear Force, $V_a = 1.0300085E-013$

EDGE -B-

Bending Moment, $M_b = 1.2067021E-010$

Shear Force, $V_b = -1.0300085E-013$

BOTH EDGES

Axial Force, $F = -4363.489$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{sl} = 709.9999$

-Compression: $A_{sc} = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{sl,ten} = 911.0619$

-Compression: $A_{sl,com} = 911.0619$

-Middle: $As_{l,mid} = 556.0619$

Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 15.20$

New component: From table 7-7, ASCE 41-17: Final Shear Capacity $VR = 1.0 \cdot V_n = 339071.608$
 V_n ((22.5.1.1), ACI 318-14) = 339071.608

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

From Table (22.5.5.1), ACI 318-14: $V_c = 171520.00$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c,jacket} \cdot Area_{jacket} + f'_{c,core} \cdot Area_{core}) / Area_{section} = 25.00$, but $f'_c^{0.5} \leq 8.3$
MPa (22.5.3.1, ACI 318-14)

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

As (tension reinf.) = 709.9999

$b_w = 670.00$

$d = 320.00$

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

$M_u = 1.2067021E-010$

$V_u = 1.0300085E-013$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 167551.608$

$V_{s1} = 167551.608$ is calculated for jacket, with:

$d = 320.00$

$A_v = 157079.633$

$f_y = 500.00$

$s = 150.00$

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

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

$d = 160.00$

$A_v = 100530.965$

$f_y = 500.00$

$s = 300.00$

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

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

From (11-11), ACI 440: $V_s + V_f \leq 712133.705$

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

At local axis: 2

Integration Section: (b)

Calculation No. 6

beam B1, Floor 1

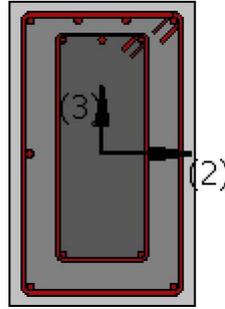
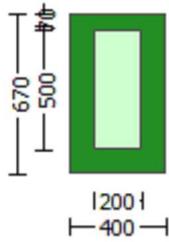
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (θ_u)

Edge: End

Local Axis: (2)



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

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

Constant Properties

Knowledge Factor, $\gamma = 1.00$
 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, $f_s = f_{sm} = 555.5556$
 Concrete Elasticity, $E_c = 26999.444$
 Steel Elasticity, $E_s = 200000.00$

Existing Column
 New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
 New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.5556$
 Concrete Elasticity, $E_c = 26999.444$
 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, $f_s = 1.25 \cdot f_{sm} = 694.4444$
 Existing Column
 New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 694.4444$
 #####

External Height, $H = 670.00$
 External Width, $W = 400.00$
 Internal Height, $H = 500.00$
 Internal Width, $W = 200.00$
 Cover Thickness, $c = 25.00$
 Mean Confinement Factor overall section = 1.03245
 Element Length, $L = 3000.00$
 Secondary Member
 Smooth Bars
 Ductile Steel
 With Detailing for Earthquake Resistance (including stirrups closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Lap Length $l_o = 300.00$
 No FRP Wrapping

Stepwise Properties

At local axis: 3
 EDGE -A-
 Shear Force, $V_a = 9840.633$
 EDGE -B-
 Shear Force, $V_b = 9840.633$
 BOTH EDGES

Axial Force, $F = -2237.255$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $As_t = 709.9999$
-Compression: $As_c = 1668.186$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $As_{t,ten} = 709.9999$
-Compression: $As_{c,com} = 1266.062$
-Middle: $As_{c,mid} = 402.1239$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.2867466$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 160061.187$
with

$M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 2.2533E+008$
 $Mu_{1+} = 1.1683E+008$, 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
 $Mu_{1-} = 2.2533E+008$, 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
 $M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 2.2533E+008$
 $Mu_{2+} = 1.1683E+008$, 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
 $Mu_{2-} = 2.2533E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination
and
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$
with
 $V_1 = 9840.633$, is the shear force acting at edge 1 for the static loading combination
 $V_2 = 9840.633$, is the shear force acting at edge 2 for the static loading combination

Calculation of Mu_{1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 6.1426221E-006$
 $M_u = 1.1683E+008$

with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.00027032$
 $N = 2237.255$
 $f_c = 33.00$
 ϕ_c (5A.5, TBDY) = 0.002
Final value of ϕ_c : $\phi_c^* = \text{shear_factor} \cdot \text{Max}(\phi_c, \phi_c) = 0.00650344$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $\phi_c = 0.00650344$
 w_e (5.4c) = 0.00563792
 ase ((5.4d), TBDY) = $(ase_1 \cdot A_{ext} + ase_2 \cdot A_{int})/A_{sec} = 0.14776895$
 $ase_1 = 0.14776895$
 $bo_1 = 340.00$
 $ho_1 = 610.00$
 $bi_2_1 = 975400.00$
 $ase_2 = \text{Max}(ase_1, ase_2) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi_2_2 = 557856.00$
 $psh_{min} \cdot F_{ywe} = \text{Min}(psh_{x} \cdot F_{ywe}, psh_{y} \cdot F_{ywe}) = 1.25907$

 $psh_x \cdot F_{ywe} = psh_1 \cdot F_{ywe1} + ps_2 \cdot F_{ywe2} = 2.25221$
 ps_1 (external) = $(A_{sh1} \cdot h_1/s_1)/A_{sec} = 0.00261799$
 $A_{sh1} = Astir_1 \cdot ns_1 = 157.0796$

No stirups, ns₁ = 2.00
h₁ = 670.00
ps₂ (internal) = (Ash₂*h₂/s₂)/Asec = 0.00062519
Ash₂ = Astir₂*ns₂ = 100.531
No stirups, ns₂ = 2.00
h₂ = 500.00

psh_y*Fywe = psh₁*Fywe₁+ps₂*Fywe₂ = 1.25907
ps₁ (external) = (Ash₁*h₁/s₁)/Asec = 0.00156298
Ash₁ = Astir₁*ns₁ = 157.0796
No stirups, ns₁ = 2.00
h₁ = 400.00
ps₂ (internal) = (Ash₂*h₂/s₂)/Asec = 0.00025008
Ash₂ = Astir₂*ns₂ = 100.531
No stirups, ns₂ = 2.00
h₂ = 200.00

Asec = 268000.00
s₁ = 150.00
s₂ = 300.00
fywe₁ = 694.4444
fywe₂ = 694.4444
fce = 33.00

From ((5.A.5), TBDY), TBDY: cc = 0.00232446
c = confinement factor = 1.03245

y₁ = 0.00097781
sh₁ = 0.003129
ft₁ = 325.9374
fy₁ = 271.6145
su₁ = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.17502824

su₁ = 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 y₁, sh₁,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/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} = 271.6145

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

y₂ = 0.00097781
sh₂ = 0.003129
ft₂ = 325.9374
fy₂ = 271.6145
su₂ = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with 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} = 0.17502824

su₂ = 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 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/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} = 271.6145

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

y_v = 0.00097781
sh_v = 0.003129
ft_v = 325.9374
fy_v = 271.6145
suv = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.17502824

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

From table 5A.1, TBDY: $esuv_nominal = 0.08$,
considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
For calculation of $esuv_nominal$ and yv , shv , 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 $fsv = (fs_jacket * Asl_mid_jacket + fs_mid * Asl_mid_core) / Asl_mid = 271.6145$

with $Esv = (Es_jacket * Asl_mid_jacket + Es_mid * Asl_mid_core) / Asl_mid = 200000.00$

$1 = Asl_ten / (b * d) * (fs1 / fc) = 0.02330074$

$2 = Asl_com / (b * d) * (fs2 / fc) = 0.04154956$

$v = Asl_mid / (b * d) * (fsv / fc) = 0.01319688$

and confined core properties:

$b = 340.00$

$d = 597.00$

$d' = 13.00$

fcc (5A.2, TBDY) = 34.07072

cc (5A.5, TBDY) = 0.00232446

$c =$ confinement factor = 1.03245

$1 = Asl_ten / (b * d) * (fs1 / fc) = 0.02879016$

$2 = Asl_com / (b * d) * (fs2 / fc) = 0.0513382$

$v = Asl_mid / (b * d) * (fsv / fc) = 0.01630593$

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

--->

$v < vsy2$ - LHS eq.(4.5) is satisfied

--->

su (4.9) = 0.18757351

$Mu = MRc$ (4.14) = 1.1683E+008

$u = su$ (4.1) = 6.1426221E-006

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.17502824$

$lb = 300.00$

$ld = 1714.009$

Calculation of lb_{min} according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

ld_{min} from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

$db = 15.23077$

Mean strength value of all re-bars: $fy = 694.4444$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$Ktr = 2.64216$

$n = 13.00$

Calculation of $Mu1$ -

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

$u = 6.3198187E-006$

$Mu = 2.2533E+008$

with full section properties:

$b = 400.00$

$d = 627.00$

$d' = 43.00$

$v = 0.00027032$

$N = 2237.255$

$fc = 33.00$

co (5A.5, TBDY) = 0.002

Final value of cu : $cu^* = shear_factor * Max(cu, cc) = 0.00650344$

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

From (5.4b), TBDY: $c_u = 0.00650344$
we (5.4c) = 0.00563792
ase ((5.4d), TBDY) = $(ase1 \cdot A_{ext} + ase2 \cdot A_{int}) / A_{sec} = 0.14776895$
ase1 = 0.14776895
bo_1 = 340.00
ho_1 = 610.00
bi2_1 = 975400.00
ase2 = $\text{Max}(ase1, ase2) = 0.14776895$
bo_2 = 192.00
ho_2 = 492.00
bi2_2 = 557856.00
psh,min*Fywe = $\text{Min}(psh,x \cdot Fywe, psh,y \cdot Fywe) = 1.25907$

psh_x*Fywe = $psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 2.25221$
ps1 (external) = $(Ash1 \cdot h1 / s1) / A_{sec} = 0.00261799$
Ash1 = $A_{stir_1} \cdot ns_1 = 157.0796$
No stirups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = $(Ash2 \cdot h2 / s2) / A_{sec} = 0.00062519$
Ash2 = $A_{stir_2} \cdot ns_2 = 100.531$
No stirups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = $psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 1.25907$
ps1 (external) = $(Ash1 \cdot h1 / s1) / A_{sec} = 0.00156298$
Ash1 = $A_{stir_1} \cdot ns_1 = 157.0796$
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = $(Ash2 \cdot h2 / s2) / A_{sec} = 0.00025008$
Ash2 = $A_{stir_2} \cdot ns_2 = 100.531$
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 268000.00
s1 = 150.00
s2 = 300.00
fywe1 = 694.4444
fywe2 = 694.4444
fce = 33.00

From ((5.A5), TBDY), TBDY: $cc = 0.00232446$
c = confinement factor = 1.03245

y1 = 0.00097781
sh1 = 0.003129
ft1 = 325.9374
fy1 = 271.6145
su1 = 0.003129

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

lo/lou,min = $l_b / l_d = 0.17502824$

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 $\text{Min}(1, 1.25 \cdot (l_b / l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs1 = (fs_jacket \cdot A_{s,ten,jacket} + fs_core \cdot A_{s,ten,core}) / A_{s,ten} = 271.6145$

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

y2 = 0.00097781
sh2 = 0.003129
ft2 = 325.9374
fy2 = 271.6145
su2 = 0.003129

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

lo/lou,min = $l_b / l_{b,min} = 0.17502824$

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 $fs2 = (fs_jacket \cdot Asl,com,jacket + fs_core \cdot Asl,com,core) / Asl,com = 271.6145$

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

$yv = 0.000977781$

$shv = 0.003129$

$ftv = 325.9374$

$fyv = 271.6145$

$suv = 0.003129$

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

and also multiplied by the $shear_factor$ according to 15.7.1.4, with

$Shear_factor = 1.00$

$lo/lo, min = lb/ld = 0.17502824$

$suv = 0.4 \cdot esuv_nominal$ ((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 $fsv = (fs_jacket \cdot Asl,mid,jacket + fs_mid \cdot Asl,mid,core) / Asl,mid = 271.6145$

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

$1 = Asl,ten / (b \cdot d) \cdot (fs1 / fc) = 0.04154956$

$2 = Asl,com / (b \cdot d) \cdot (fs2 / fc) = 0.02330074$

$v = Asl,mid / (b \cdot d) \cdot (fsv / fc) = 0.01319688$

and confined core properties:

$b = 340.00$

$d = 597.00$

$d' = 13.00$

fcc (5A.2, TBDY) = 34.07072

cc (5A.5, TBDY) = 0.00232446

$c =$ confinement factor = 1.03245

$1 = Asl,ten / (b \cdot d) \cdot (fs1 / fc) = 0.0513382$

$2 = Asl,com / (b \cdot d) \cdot (fs2 / fc) = 0.02879016$

$v = Asl,mid / (b \cdot d) \cdot (fsv / fc) = 0.01630593$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

su (4.9) = 0.21035251

$Mu = MRc$ (4.14) = 2.2533E+008

$u = su$ (4.1) = 6.3198187E-006

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.17502824$

$lb = 300.00$

$ld = 1714.009$

Calculation of lb, min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

ld, min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

$db = 15.23077$

Mean strength value of all re-bars: $fy = 694.4444$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$Ktr = 2.64216$

$n = 13.00$

Calculation of $Mu2+$

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

$$u = 6.1426221E-006$$

$$\mu = 1.1683E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.00650344$$

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

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.00650344$$

$$\phi_{we} \text{ (5.4c)} = 0.00563792$$

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

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

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

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$\text{psh}_{\min} * F_{ywe} = \text{Min}(\text{psh}_{x} * F_{ywe}, \text{psh}_{y} * F_{ywe}) = 1.25907$$

$$\text{psh}_{x} * F_{ywe} = \text{psh}_1 * F_{ywe1} + \text{ps}_2 * F_{ywe2} = 2.25221$$

$$\text{ps}_1 \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

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

No stirups, $n_{s_1} = 2.00$

$$h_1 = 670.00$$

$$\text{ps}_2 \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

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

No stirups, $n_{s_2} = 2.00$

$$h_2 = 500.00$$

$$\text{psh}_{y} * F_{ywe} = \text{psh}_1 * F_{ywe1} + \text{ps}_2 * F_{ywe2} = 1.25907$$

$$\text{ps}_1 \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

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

No stirups, $n_{s_1} = 2.00$

$$h_1 = 400.00$$

$$\text{ps}_2 \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

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

No stirups, $n_{s_2} = 2.00$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.4444$$

$$f_{ywe2} = 694.4444$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A.5), TBDY), TBDY: } \phi_{cc} = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$y_1 = 0.00097781$$

$$sh_1 = 0.003129$$

$$ft_1 = 325.9374$$

$$fy_1 = 271.6145$$

$$su_1 = 0.003129$$

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

$$l_o / l_{ou, \min} = l_b / d = 0.17502824$$

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

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 $fs1 = (fs_jacket \cdot Asl,ten,jacket + fs_core \cdot Asl,ten,core) / Asl,ten = 271.6145$

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

$$y2 = 0.00097781$$

$$sh2 = 0.003129$$

$$ft2 = 325.9374$$

$$fy2 = 271.6145$$

$$su2 = 0.003129$$

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

and also multiplied by the $shear_factor$ according to 15.7.1.4, with

$Shear_factor = 1.00$

$$lo/lou,min = lb/lb,min = 0.17502824$$

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

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 $fs2 = (fs_jacket \cdot Asl,com,jacket + fs_core \cdot Asl,com,core) / Asl,com = 271.6145$

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

$$yv = 0.00097781$$

$$shv = 0.003129$$

$$ftv = 325.9374$$

$$fyv = 271.6145$$

$$suv = 0.003129$$

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

and also multiplied by the $shear_factor$ according to 15.7.1.4, with

$Shear_factor = 1.00$

$$lo/lou,min = lb/ld = 0.17502824$$

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

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

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

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

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

with $fsv = (fs_jacket \cdot Asl,mid,jacket + fs_mid \cdot Asl,mid,core) / Asl,mid = 271.6145$

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

$$1 = Asl,ten / (b \cdot d) \cdot (fs1 / fc) = 0.02330074$$

$$2 = Asl,com / (b \cdot d) \cdot (fs2 / fc) = 0.04154956$$

$$v = Asl,mid / (b \cdot d) \cdot (fsv / fc) = 0.01319688$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc \text{ (5A.2, TBDY)} = 34.07072$$

$$cc \text{ (5A.5, TBDY)} = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$1 = Asl,ten / (b \cdot d) \cdot (fs1 / fc) = 0.02879016$$

$$2 = Asl,com / (b \cdot d) \cdot (fs2 / fc) = 0.0513382$$

$$v = Asl,mid / (b \cdot d) \cdot (fsv / fc) = 0.01630593$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$$su \text{ (4.9)} = 0.18757351$$

$$Mu = MRc \text{ (4.14)} = 1.1683E+008$$

$$u = su \text{ (4.1)} = 6.1426221E-006$$

Calculation of ratio lb/ld

$$\text{Lap Length: } lb/ld = 0.17502824$$

$$lb = 300.00$$

$$ld = 1714.009$$

Calculation of $I_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $I_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1
 $db = 15.23077$
Mean strength value of all re-bars: $f_y = 694.4444$
 $t = 1.16154$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.64216$
 $n = 13.00$

Calculation of μ_2 -

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:
 $\mu = 6.3198187E-006$
 $\mu_u = 2.2533E+008$

with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.00027032$
 $N = 2237.255$
 $f_c = 33.00$
 α (5A.5, TBDY) = 0.002
Final value of μ_c : $\mu_c^* = \text{shear_factor} * \text{Max}(\mu_c, \alpha) = 0.00650344$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $\mu_c = 0.00650344$
 w_e (5.4c) = 0.00563792
 α_{se} ((5.4d), TBDY) = $(\alpha_{se1} * A_{ext} + \alpha_{se2} * A_{int}) / A_{sec} = 0.14776895$
 $\alpha_{se1} = 0.14776895$
 $b_{o,1} = 340.00$
 $h_{o,1} = 610.00$
 $b_{i2,1} = 975400.00$
 $\alpha_{se2} = \text{Max}(\alpha_{se1}, \alpha_{se2}) = 0.14776895$
 $b_{o,2} = 192.00$
 $h_{o,2} = 492.00$
 $b_{i2,2} = 557856.00$
 $p_{sh,min} * F_{ywe} = \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.25907$

 $p_{sh,x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.25221$
 p_{s1} (external) = $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir,1} * n_{s,1} = 157.0796$
No stirups, $n_{s,1} = 2.00$
 $h_1 = 670.00$
 p_{s2} (internal) = $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$
 $A_{sh2} = A_{stir,2} * n_{s,2} = 100.531$
No stirups, $n_{s,2} = 2.00$
 $h_2 = 500.00$

 $p_{sh,y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.25907$
 p_{s1} (external) = $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$
 $A_{sh1} = A_{stir,1} * n_{s,1} = 157.0796$
No stirups, $n_{s,1} = 2.00$
 $h_1 = 400.00$
 p_{s2} (internal) = $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$
 $A_{sh2} = A_{stir,2} * n_{s,2} = 100.531$
No stirups, $n_{s,2} = 2.00$
 $h_2 = 200.00$

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

$s_2 = 300.00$
 $fy_{we1} = 694.4444$
 $fy_{we2} = 694.4444$
 $f_{ce} = 33.00$
 From ((5.A5), TBDY), TBDY: $cc = 0.00232446$
 $c = \text{confinement factor} = 1.03245$
 $y_1 = 0.00097781$
 $sh_1 = 0.003129$
 $ft_1 = 325.9374$
 $fy_1 = 271.6145$
 $su_1 = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou, \min = lb/d = 0.17502824$
 $su_1 = 0.4 * esu_1 \text{ nominal ((5.5), TBDY)} = 0.032$
 From table 5A.1, TBDY: $esu_1 \text{ nominal} = 0.08$,
 For calculation of $esu_1 \text{ nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered
 characteristic value $fsy_1 = fs_1/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_1 = (fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 271.6145$
 with $Es_1 = (Es_{jacket} * A_{sl,ten,jacket} + Es_{core} * A_{sl,ten,core}) / A_{sl,ten} = 200000.00$
 $y_2 = 0.00097781$
 $sh_2 = 0.003129$
 $ft_2 = 325.9374$
 $fy_2 = 271.6145$
 $su_2 = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou, \min = lb/lb, \min = 0.17502824$
 $su_2 = 0.4 * esu_2 \text{ nominal ((5.5), TBDY)} = 0.032$
 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 $\text{Min}(1, 1.25 * (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 271.6145$
 with $Es_2 = (Es_{jacket} * A_{sl,com,jacket} + Es_{core} * A_{sl,com,core}) / A_{sl,com} = 200000.00$
 $y_v = 0.00097781$
 $sh_v = 0.003129$
 $ft_v = 325.9374$
 $fy_v = 271.6145$
 $suv = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou, \min = lb/d = 0.17502824$
 $suv = 0.4 * esuv \text{ nominal ((5.5), TBDY)} = 0.032$
 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 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 $\text{Min}(1, 1.25 * (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs_{jacket} * A_{sl,mid,jacket} + fs_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 271.6145$
 with $Es_v = (Es_{jacket} * A_{sl,mid,jacket} + Es_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$
 $1 = A_{sl,ten} / (b * d) * (fs_1 / f_c) = 0.04154956$
 $2 = A_{sl,com} / (b * d) * (fs_2 / f_c) = 0.02330074$
 $v = A_{sl,mid} / (b * d) * (fsv / f_c) = 0.01319688$
 and confined core properties:
 $b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $f_{cc} \text{ (5A.2, TBDY)} = 34.07072$
 $cc \text{ (5A.5, TBDY)} = 0.00232446$
 $c = \text{confinement factor} = 1.03245$
 $1 = A_{sl,ten} / (b * d) * (fs_1 / f_c) = 0.0513382$
 $2 = A_{sl,com} / (b * d) * (fs_2 / f_c) = 0.02879016$

$$v = A_{sl, mid} / (b * d) * (f_{sv} / f_c) = 0.01630593$$

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

--->

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

--->

$$s_u(4.9) = 0.21035251$$

$$\mu = M_{Rc}(4.14) = 2.2533E+008$$

$$u = s_u(4.1) = 6.3198187E-006$$

Calculation of ratio l_b / l_d

Lap Length: $l_b / l_d = 0.17502824$

$$l_b = 300.00$$

$$l_d = 1714.009$$

Calculation of l_b, min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

l_d, min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$d_b = 15.23077$$

$$\text{Mean strength value of all re-bars: } f_y = 694.4444$$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 558197.326$

Calculation of Shear Strength at edge 1, $V_{r1} = 558197.326$

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

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

From Table (22.5.5.1), ACI 318-14: $V_c = 209131.476$

= 1 (normal-weight concrete)

Mean concrete strength: $f'_c = (f'_{c, jacket} * \text{Area}_{jacket} + f'_{c, core} * \text{Area}_{core}) / \text{Area}_{section} = 33.00$, but $f'_c^{0.5} \leq 8.3$
MPa (22.5.3.1, ACI 318-14)

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

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

$$b_w = 400.00$$

$$d = 536.00$$

$$V_u * d / \mu < 1 = 1.00$$

$$\mu = 1.0197E+006$$

$$V_u = 9840.633$$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 349065.85$

$V_{s1} = 311832.16$ is calculated for jacket, with:

$$d = 536.00$$

$$A_v = 157079.633$$

$$f_y = 555.5556$$

$$s = 150.00$$

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

$V_{s2} = 37233.691$ is calculated for jacket, with:

$$d_2 = 400.00$$

$$A_v = 100530.965$$

$$f_y = 555.5556$$

$$s = 300.00$$

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

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

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

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 818179.336$$

Calculation of Shear Strength at edge 2, Vr2 = 558197.326
Vr2 = Vn ((22.5.1.1), ACI 318-14)

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

From Table (22.5.5.1), ACI 318-14: Vc = 209131.476
= 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc'^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
pw = As/(bw*d) = 0.00331157
As (tension reinf.) = 709.9999
bw = 400.00
d = 536.00
Vu*d/Mu < 1 = 1.00
Mu = 1.0197E+006
Vu = 9840.633
From (11.5.4.8), ACI 318-14: Vs1 + Vs2 = 349065.85
Vs1 = 311832.16 is calculated for jacket, with:
d = 536.00
Av = 157079.633
fy = 555.5556
s = 150.00
Vs1 has been multiplied by 1 (s<d/2, according to ASCE 41-17,10.3.4)
Vs2 = 37233.691 is calculated for jacket, with:
d = 400.00
Av = 100530.965
fy = 555.5556
s = 300.00
Vs2 has been multiplied by 2(1-s/d) (s>d/2, according to ASCE 41-17,10.3.4)
2(1-s/d) = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 818179.336

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

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

Constant Properties

Knowledge Factor, = 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 = 555.5556
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.5556
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.4444
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.4444

#####

External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03245
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length l_o = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, V_a = -2.6375953E-014
EDGE -B-
Shear Force, V_b = 2.6375953E-014
BOTH EDGES
Axial Force, F = -2237.255
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{sl,t}$ = 709.9999
-Compression: $A_{sl,c}$ = 1668.186
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{sl,ten}$ = 911.0619
-Compression: $A_{sl,com}$ = 911.0619
-Middle: $A_{sl,mid}$ = 556.0619

Calculation of Shear Capacity ratio , V_e/V_r = 0.15892241
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u * l_n / 2 = 60903.823$
with
 $M_{pr1} = \text{Max}(Mu_{1+} , Mu_{1-}) = 9.1356E+007$
 $Mu_{1+} = 9.1356E+007$, 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
 $Mu_{1-} = 9.1356E+007$, 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
 $M_{pr2} = \text{Max}(Mu_{2+} , Mu_{2-}) = 9.1356E+007$
 $Mu_{2+} = 9.1356E+007$, 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
 $Mu_{2-} = 9.1356E+007$, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination
and
 $\pm w_u * l_n = (|V_1| + |V_2|)/2$
with
 $V_1 = -2.6375953E-014$, is the shear force acting at edge 1 for the the static loading combination
 $V_2 = 2.6375953E-014$, is the shear force acting at edge 2 for the the static loading combination

Calculation of Mu_{1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 1.1029765E-005$
 $Mu = 9.1356E+007$

with full section properties:

$b = 670.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.00028344$
 $N = 2237.255$
 $f_c = 33.00$
 $c_o (5A.5, TBDY) = 0.002$
 Final value of c_u : $c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00650344$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $c_u = 0.00650344$
 $w_e (5.4c) = 0.00563792$
 $a_{se} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$
 $a_{se1} = 0.14776895$
 $b_{o_1} = 340.00$
 $h_{o_1} = 610.00$
 $b_{i2_1} = 975400.00$
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$
 $b_{o_2} = 192.00$
 $h_{o_2} = 492.00$
 $b_{i2_2} = 557856.00$
 $p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25907$

$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.25221$
 $p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirups, $n_{s_1} = 2.00$
 $h_1 = 670.00$
 $p_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirups, $n_{s_2} = 2.00$
 $h_2 = 500.00$

$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.25907$
 $p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirups, $n_{s_1} = 2.00$
 $h_1 = 400.00$
 $p_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirups, $n_{s_2} = 2.00$
 $h_2 = 200.00$

$A_{sec} = 268000.00$
 $s_1 = 150.00$
 $s_2 = 300.00$
 $f_{ywe1} = 694.4444$
 $f_{ywe2} = 694.4444$
 $f_{ce} = 33.00$

From ((5.A5), TBDY), TBDY: $c_c = 0.00232446$
 $c = \text{confinement factor} = 1.03245$

$y_1 = 0.00097781$
 $sh_1 = 0.003129$
 $ft_1 = 325.9374$
 $fy_1 = 271.6145$
 $su_1 = 0.003129$

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

$l_o / l_{ou, \min} = l_b / d = 0.17502824$
 $su_1 = 0.4 * e_{su1_nominal} ((5.5), TBDY) = 0.032$

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 $f_{sy1} = f_{s1} / 1.2$, from table 5.1, TBDY.

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

with $f_{s1} = (f_{s, \text{jacket}} * A_{s1, \text{ten, jacket}} + f_{s, \text{core}} * A_{s1, \text{ten, core}}) / A_{s1, \text{ten}}$ = 271.6145

with $E_{s1} = (E_{s, \text{jacket}} * A_{s1, \text{ten, jacket}} + E_{s, \text{core}} * A_{s1, \text{ten, core}}) / A_{s1, \text{ten}}$ = 200000.00

$y_2 = 0.00097781$

$sh_2 = 0.003129$
 $ft_2 = 325.9374$
 $fy_2 = 271.6145$
 $su_2 = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/lb,min = 0.17502824$
 $su_2 = 0.4*esu_2,nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_2,nominal = 0.08$,
 For calculation of $esu_2,nominal$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 271.6145$
 with $Es_2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00$
 $yv = 0.00097781$
 $shv = 0.003129$
 $ftv = 325.9374$
 $fyv = 271.6145$
 $suv = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/ld = 0.17502824$
 $suv = 0.4*esuv,nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv,nominal = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv,nominal$ and yv, shv, ftv, fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 271.6145$
 with $Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00$
 $1 = Asl,ten/(b*d)*(fs_1/fc) = 0.03135046$
 $2 = Asl,com/(b*d)*(fs_2/fc) = 0.03135046$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.01913459$

and confined core properties:

$b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 34.07072$
 $cc (5A.5, TBDY) = 0.00232446$
 $c = \text{confinement factor} = 1.03245$
 $1 = Asl,ten/(b*d)*(fs_1/fc) = 0.0375932$
 $2 = Asl,com/(b*d)*(fs_2/fc) = 0.0375932$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.02294481$

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

--->
 $v < v_{s,y_2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.20535904$
 $Mu = MRc (4.14) = 9.1356E+007$
 $u = su (4.1) = 1.1029765E-005$

 Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.17502824$
 $lb = 300.00$
 $ld = 1714.009$
 Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 15.23077$
 Mean strength value of all re-bars: $fy = 694.4444$
 $t = 1.16154$
 $s = 0.80$

e = 1.00
cb = 25.00
Ktr = 2.64216
n = 13.00

Calculation of Mu1-

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

u = 1.1029765E-005
Mu = 9.1356E+007

with full section properties:

b = 670.00
d = 357.00
d' = 43.00
v = 0.00028344
N = 2237.255
fc = 33.00
co (5A.5, TBDY) = 0.002

Final value of c_u : $c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00650344$
The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $c_u = 0.00650344$

we (5.4c) = 0.00563792

ase ((5.4d), TBDY) = $(\text{ase1} * \text{Aext} + \text{ase2} * \text{Aint}) / \text{Asec} = 0.14776895$

ase1 = 0.14776895

bo_1 = 340.00

ho_1 = 610.00

bi2_1 = 975400.00

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

bo_2 = 192.00

ho_2 = 492.00

bi2_2 = 557856.00

$\text{psh}_{\text{min}} * \text{Fywe} = \text{Min}(\text{psh}_x * \text{Fywe}, \text{psh}_y * \text{Fywe}) = 1.25907$

 $\text{psh}_x * \text{Fywe} = \text{psh1} * \text{Fywe1} + \text{ps2} * \text{Fywe2} = 2.25221$

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

Ash1 = $\text{Astir}_1 * \text{ns}_1 = 157.0796$

No stirups, ns_1 = 2.00

h1 = 670.00

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

Ash2 = $\text{Astir}_2 * \text{ns}_2 = 100.531$

No stirups, ns_2 = 2.00

h2 = 500.00

 $\text{psh}_y * \text{Fywe} = \text{psh1} * \text{Fywe1} + \text{ps2} * \text{Fywe2} = 1.25907$

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

Ash1 = $\text{Astir}_1 * \text{ns}_1 = 157.0796$

No stirups, ns_1 = 2.00

h1 = 400.00

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

Ash2 = $\text{Astir}_2 * \text{ns}_2 = 100.531$

No stirups, ns_2 = 2.00

h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.4444

fywe2 = 694.4444

fce = 33.00

From ((5.A5), TBDY), TBDY: $c_c = 0.00232446$

c = confinement factor = 1.03245

y1 = 0.00097781

$sh1 = 0.003129$
 $ft1 = 325.9374$
 $fy1 = 271.6145$
 $su1 = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/ld = 0.17502824$
 $su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032$
 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 $fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 271.6145$
 with $Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00$
 $y2 = 0.00097781$
 $sh2 = 0.003129$
 $ft2 = 325.9374$
 $fy2 = 271.6145$
 $su2 = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/lb,min = 0.17502824$
 $su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032$
 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 $fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 271.6145$
 with $Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00$
 $yv = 0.00097781$
 $shv = 0.003129$
 $ftv = 325.9374$
 $fyv = 271.6145$
 $suv = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/ld = 0.17502824$
 $suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv, shv,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 $fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 271.6145$
 with $Es_v = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.03135046$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.03135046$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.01913459$
 and confined core properties:
 $b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 34.07072$
 $cc (5A.5, TBDY) = 0.00232446$
 $c = \text{confinement factor} = 1.03245$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.0375932$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.0375932$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.02294481$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < vs,y2$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.20535904$

$$\begin{aligned} \mu &= MRC(4.14) = 9.1356E+007 \\ u &= su(4.1) = 1.1029765E-005 \end{aligned}$$

Calculation of ratio lb/l_d

$$\text{Lap Length: } lb/l_d = 0.17502824$$

$$lb = 300.00$$

$$l_d = 1714.009$$

Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

l_{d,min} from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$db = 15.23077$$

$$\text{Mean strength value of all re-bars: } f_y = 694.4444$$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$cb = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of μ_{2+}

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

$$u = 1.1029765E-005$$

$$\mu = 9.1356E+007$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00650344$$

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

$$\text{From (5.4b), TBDY: } c_u = 0.00650344$$

$$w_e(5.4c) = 0.00563792$$

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

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

$$ho_1 = 610.00$$

$$bi_2_1 = 975400.00$$

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

$$bo_2 = 192.00$$

$$ho_2 = 492.00$$

$$bi_2_2 = 557856.00$$

$$psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.25907$$

$$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.25221$$

$$ps1(\text{external}) = (A_{sh1} * h1 / s1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * ns_1 = 157.0796$$

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

$$h1 = 670.00$$

$$ps2(\text{internal}) = (A_{sh2} * h2 / s2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * ns_2 = 100.531$$

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

$$h2 = 500.00$$

$$psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.25907$$

$$ps1(\text{external}) = (A_{sh1} * h1 / s1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * ns_1 = 157.0796$$

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

 $Asec = 268000.00$
 $s1 = 150.00$
 $s2 = 300.00$
 $fywe1 = 694.4444$
 $fywe2 = 694.4444$
 $fce = 33.00$

From ((5.A.5), TBDY), TBDY: $cc = 0.00232446$
 $c =$ confinement factor = 1.03245

$y1 = 0.00097781$
 $sh1 = 0.003129$
 $ft1 = 325.9374$
 $fy1 = 271.6145$
 $su1 = 0.003129$

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

$lo/lou,min = lb/ld = 0.17502824$
 $su1 = 0.4 \cdot esu1_nominal$ ((5.5), TBDY) = 0.032

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

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

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

with $fs1 = (fs,jacket \cdot Asl,ten,jacket + fs,core \cdot Asl,ten,core) / Asl,ten = 271.6145$

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

$y2 = 0.00097781$
 $sh2 = 0.003129$
 $ft2 = 325.9374$
 $fy2 = 271.6145$
 $su2 = 0.003129$

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

$lo/lou,min = lb/lb,min = 0.17502824$
 $su2 = 0.4 \cdot esu2_nominal$ ((5.5), TBDY) = 0.032

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

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

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

with $fs2 = (fs,jacket \cdot Asl,com,jacket + fs,core \cdot Asl,com,core) / Asl,com = 271.6145$

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

$yv = 0.00097781$
 $shv = 0.003129$
 $ftv = 325.9374$
 $fyv = 271.6145$
 $suv = 0.003129$

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

$lo/lou,min = lb/ld = 0.17502824$
 $suv = 0.4 \cdot esuv_nominal$ ((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 $fsv = (fs,jacket \cdot Asl,mid,jacket + fs,mid \cdot Asl,mid,core) / Asl,mid = 271.6145$

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

$1 = Asl,ten / (b \cdot d) \cdot (fs1 / fc) = 0.03135046$
 $2 = Asl,com / (b \cdot d) \cdot (fs2 / fc) = 0.03135046$
 $v = Asl,mid / (b \cdot d) \cdot (fsv / fc) = 0.01913459$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$fcc \text{ (5A.2, TBDY)} = 34.07072$$

$$cc \text{ (5A.5, TBDY)} = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.0375932$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.0375932$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.02294481$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$$s_u \text{ (4.9)} = 0.20535904$$

$$M_u = MR_c \text{ (4.14)} = 9.1356E+007$$

$$u = s_u \text{ (4.1)} = 1.1029765E-005$$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.17502824$

$$l_b = 300.00$$

$$l_d = 1714.009$$

Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$d_b = 15.23077$$

Mean strength value of all re-bars: $f_y = 694.4444$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of M_{u2} -

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

$$u = 1.1029765E-005$$

$$M_u = 9.1356E+007$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

Final value of c_u : $c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00650344$

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

From (5.4b), TBDY: $c_u = 0.00650344$

$$w_e \text{ (5.4c)} = 0.00563792$$

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

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

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

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$bi2_2 = 557856.00$$

$$psh,min*Fywe = \text{Min}(psh,x*Fywe, psh,y*Fywe) = 1.25907$$

$$psh_x*Fywe = psh1*Fywe1 + ps2*Fywe2 = 2.25221$$

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

$$Ash1 = Astir_1*ns_1 = 157.0796$$

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

$$h1 = 670.00$$

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

$$Ash2 = Astir_2*ns_2 = 100.531$$

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

$$h2 = 500.00$$

$$psh_y*Fywe = psh1*Fywe1 + ps2*Fywe2 = 1.25907$$

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

$$Ash1 = Astir_1*ns_1 = 157.0796$$

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

$$h1 = 400.00$$

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

$$Ash2 = Astir_2*ns_2 = 100.531$$

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

$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 694.4444$$

$$fywe2 = 694.4444$$

$$fce = 33.00$$

$$\text{From } ((5.A.5), \text{ TBDY}), \text{ TBDY: } cc = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$y1 = 0.00097781$$

$$sh1 = 0.003129$$

$$ft1 = 325.9374$$

$$fy1 = 271.6145$$

$$su1 = 0.003129$$

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

$$lo/lou,min = lb/l_d = 0.17502824$$

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

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.

$$\text{with } fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 271.6145$$

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

$$y2 = 0.00097781$$

$$sh2 = 0.003129$$

$$ft2 = 325.9374$$

$$fy2 = 271.6145$$

$$su2 = 0.003129$$

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

$$lo/lou,min = lb/l_b,min = 0.17502824$$

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

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.

$$\text{with } fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 271.6145$$

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

$$yv = 0.00097781$$

$$shv = 0.003129$$

$$ftv = 325.9374$$

$$fyv = 271.6145$$

$$suv = 0.003129$$

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

$$lo/lou,min = lb/ld = 0.17502824$$

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

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

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

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

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

$$\text{with } fsv = (fs_jacket * Asl_mid_jacket + fs_mid * Asl_mid_core) / Asl_mid = 271.6145$$

$$\text{with } Esv = (Es_jacket * Asl_mid_jacket + Es_mid * Asl_mid_core) / Asl_mid = 200000.00$$

$$1 = Asl_ten / (b * d) * (fs1 / fc) = 0.03135046$$

$$2 = Asl_com / (b * d) * (fs2 / fc) = 0.03135046$$

$$v = Asl_mid / (b * d) * (fsv / fc) = 0.01913459$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 34.07072$$

$$cc (5A.5, TBDY) = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$1 = Asl_ten / (b * d) * (fs1 / fc) = 0.0375932$$

$$2 = Asl_com / (b * d) * (fs2 / fc) = 0.0375932$$

$$v = Asl_mid / (b * d) * (fsv / fc) = 0.02294481$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$$su (4.9) = 0.20535904$$

$$Mu = MRc (4.14) = 9.1356E+007$$

$$u = su (4.1) = 1.1029765E-005$$

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.17502824

$$lb = 300.00$$

$$ld = 1714.009$$

Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$db = 15.23077$$

Mean strength value of all re-bars: fy = 694.4444

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$cb = 25.00$$

$$Ktr = 2.64216$$

$$n = 13.00$$

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 383229.931

Calculation of Shear Strength at edge 1, Vr1 = 383229.931

$$Vr1 = Vn ((22.5.1.1), ACI 318-14)$$

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

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

From Table (22.5.5.1), ACI 318-14: Vc = 197061.477

= 1 (normal-weight concrete)

$$\text{Mean concrete strength: } fc' = (fc'_{jacket} * Area_{jacket} + fc'_{core} * Area_{core}) / Area_{section} = 33.00, \text{ but } fc'^{0.5} \leq 8.3$$

MPa (22.5.3.1, ACI 318-14)

$$pw = As/(bw*d) = 0.00331157$$

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

$$bw = 670.00$$

$$d = 320.00$$

$$Vu*d/Mu < 1 = 0.00$$

$$Mu = 2.6257021E-011$$

$$Vu = 2.6375953E-014$$

From (11.5.4.8), ACI 318-14: $Vs1 + Vs2 = 186168.454$

$Vs1 = 186168.454$ is calculated for jacket, with:

$$d = 320.00$$

$$Av = 157079.633$$

$$fy = 555.5556$$

$$s = 150.00$$

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

$Vs2 = 0.00$ is calculated for jacket, with:

$$d2 = 160.00$$

$$Av = 100530.965$$

$$fy = 555.5556$$

$$s = 300.00$$

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

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

$$\text{From (11-11), ACI 440: } Vs + Vf \leq 818179.336$$

Calculation of Shear Strength at edge 2, $Vr2 = 383229.931$

$$Vr2 = Vn \text{ ((22.5.1.1), ACI 318-14)}$$

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

From Table (22.5.5.1), ACI 318-14: $Vc = 197061.477$

= 1 (normal-weight concrete)

Mean concrete strength: $fc' = (fc'_{\text{jacket}} * Area_{\text{jacket}} + fc'_{\text{core}} * Area_{\text{core}}) / Area_{\text{section}} = 33.00$, but $fc'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$$pw = As/(bw*d) = 0.00331157$$

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

$$bw = 670.00$$

$$d = 320.00$$

$$Vu*d/Mu < 1 = 0.00$$

$$Mu = 5.2870952E-011$$

$$Vu = 2.6375953E-014$$

From (11.5.4.8), ACI 318-14: $Vs1 + Vs2 = 186168.454$

$Vs1 = 186168.454$ is calculated for jacket, with:

$$d = 320.00$$

$$Av = 157079.633$$

$$fy = 555.5556$$

$$s = 150.00$$

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

$Vs2 = 0.00$ is calculated for jacket, with:

$$d = 160.00$$

$$Av = 100530.965$$

$$fy = 555.5556$$

$$s = 300.00$$

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

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

$$\text{From (11-11), ACI 440: } Vs + Vf \leq 818179.336$$

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

At local axis: 2

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

At local axis: 2

Integration Section: (b)

Section Type: rcjars

Constant Properties

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, $f_s = f_{sm} = 555.5556$

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Existing Column

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

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.5556$

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

With Detailing for Earthquake Resistance (including stirrups closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_b = 300.00$

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 1.5895E+007$

Shear Force, $V_2 = -1.0300085E-013$

Shear Force, $V_3 = 18821.484$

Axial Force, $F = -4363.489$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{sl,t} = 709.9999$

-Compression: $A_{sl,c} = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

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

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

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

Longitudinal External Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{sl,ten,jacket} = 402.1239$

-Compression: $A_{sl,com,jacket} = 804.2477$

-Middle: $A_{sl,mid,jacket} = 402.1239$

Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{sl,ten,core} = 307.8761$

-Compression: $A_{sl,com,core} = 461.8141$

-Middle: $A_{sl,mid,core} = 0.00$

Mean Diameter of Tension Reinforcement, $Db_L = 15.00$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_{,R} = 1.0^*$ $u = 0.01043298$

$u = y + p = 0.01043298$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.00043298$ ((4.29), Biskinis Phd))

$M_y = 1.2490E+008$

$L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 844.5372

From table 10.5, ASCE 41_17: $E_{eff} = 0.3 * E_c * I_g = 8.1204E+013$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

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

$y_{ten} = 2.4693920E-006$

with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25 * f_y * (l_b/d)^{2/3}) = 252.1446$

$d = 627.00$

$y = 0.18574202$

$A = 0.0095514$

$B = 0.00410281$

with $p_t = 0.00283094$

$p_c = 0.00504809$

$p_v = 0.00160336$

$N = 4363.489$

$b = 400.00$

" = 0.06858054

$y_{comp} = 1.9036374E-005$

with $f_c = 33.00$

$E_c = 26999.444$

$y = 0.18432314$

$A = 0.00944286$

$B = 0.0040338$

with $E_s = 200000.00$

Calculation of ratio l_b/d

Lap Length: $l_d/l_{d,min} = 0.2187853$

$l_b = 300.00$

$l_d = 1371.207$

Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)

= 1

$db = 15.23077$

Mean strength value of all re-bars: $f_y = 555.5556$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

- Calculation of p -

From table 10-7: $p = 0.01$

with:

- Condition iv occurred

Beam controlled by inadequate embedment into beam-column joint:

($l_b/d < 1$ and With Lapping in the Vicinity of the End Regions

- Condition i occurred

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

shear control ratio $V_p/V_o = 0.2867466$

- Transverse Reinforcement: C

- Stirrup Spacing $\leq d/3$

- Low ductility demand, $f_y / y < 2$ (table 10-6, ASCE 41-17)

= 9.5959919E-006

- Stirrup Spacing $\leq d/2$

$d = d_{external} = 627.00$

$s = s_{external} = 150.00$

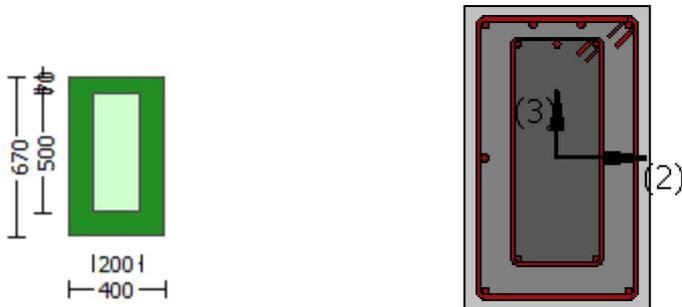
- Strength provided by hoops $V_s < 3/4 * \text{design Shear}$

$V_s = 386299.541$, already given in calculation of shear control ratio
 design Shear = 18821.484
 $\rho = A_{st}/(b_w*d) = -0.22420383$
 $\rho = A_{st}/(b_w*d) = 0.00283094$
 Tension Reinf Area: $A_{st} = 709.9999$
 $\rho = A_{sc}/(b_w*d) = 0.00665146$
 Compression Reinf Area: $A_{sc} = 1668.186$
 From (B-1), ACI 318-11: $\rho = 0.01704038$
 $f_c = (f_{c_jacket}*Area_jacket + f_{c_core}*Area_core)/section_area = 33.00$
 $f_y = f_{y_jacket_bars} = 555.5556$
 From 10.2.7.3, ACI 318-11: $\beta = 0.65$
 From fig R10.3.3, ACI 318-11 (Ence 454, too): $cb/dt = 0.003/(0.003 + \rho) = 0.51923077$
 $\rho = 0.00277778$
 $V/(b_w*d*f_c^{0.5}) = 0.15732314$, NOTE: units in lb & in
 $b_w = 400.00$

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

Calculation No. 7

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



Start Of Calculation of Shear Capacity for element: beam JB1 of floor 1
 At local axis: 3
 Integration Section: (b)
 Section Type: rcjars
 Constant Properties

Knowledge Factor, $\phi = 1.00$
 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
 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, $E_s = 200000.00$
 External Height, $H = 670.00$
 External Width, $W = 400.00$
 Internal Height, $H = 500.00$
 Internal Width, $W = 200.00$
 Cover Thickness, $c = 25.00$
 Element Length, $L = 3000.00$
 Secondary Member
 Smooth Bars
 Ductile Steel
 With Detailing for Earthquake Resistance (including stirrups closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Lap Length $l_o = l_b = 300.00$
 No FRP Wrapping

Stepwise Properties

EDGE -A-
 Bending Moment, $M_a = 1.1047E+007$
 Shear Force, $V_a = 859.7817$
 EDGE -B-
 Bending Moment, $M_b = 1.5895E+007$
 Shear Force, $V_b = 18821.484$
 BOTH EDGES
 Axial Force, $F = -4363.489$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $A_{sl} = 709.9999$
 -Compression: $A_{sc} = 1668.186$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $A_{sl,ten} = 709.9999$
 -Compression: $A_{sl,com} = 1266.062$
 -Middle: $A_{sl,mid} = 402.1239$
 Mean Diameter of Tension Reinforcement, $D_{bL,ten} = 15.00$

New component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = 1.0 \cdot V_n = 493339.697$
 V_n ((22.5.1.1), ACI 318-14) = 493339.697

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

From Table (22.5.5.1), ACI 318-14: $V_c = 179180.431$
 $= 1$ (normal-weight concrete)
 Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot Area_{jacket} + f'_{c_core} \cdot Area_{core}) / Area_{section} = 25.00$, but $f_c^{0.5} \leq 8.3$
 MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 400.00$
 $d = 536.00$
 $V_u \cdot d / \mu_u < 1 = 0.6346671$

$$M_u = 1.5895E+007$$

$$V_u = 18821.484$$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 314159.265$

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

$$d = 536.00$$

$$A_v = 157079.633$$

$$f_y = 500.00$$

$$s = 150.00$$

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

$V_{s2} = 33510.322$ is calculated for core, with:

$$d = 400.00$$

$$A_v = 100530.965$$

$$f_y = 500.00$$

$$s = 300.00$$

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

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

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

$$\text{From } (11-11), ACI 440: V_s + V_f \leq 712133.705$$

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

At local axis: 3

Integration Section: (b)

Calculation No. 8

beam B1, Floor 1

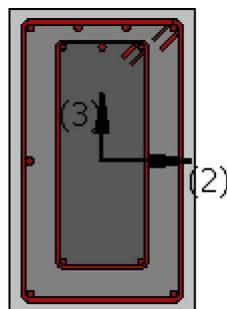
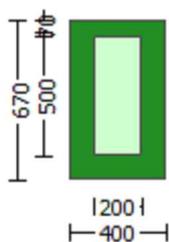
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (θ)

Edge: End

Local Axis: (3)



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

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\phi = 1.00$
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, $f_s = f_{sm} = 555.5556$
Concrete Elasticity, $E_c = 26999.444$
Steel Elasticity, $E_s = 200000.00$
Existing Column
New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.5556$
Concrete Elasticity, $E_c = 26999.444$
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, $f_s = 1.25 * f_{sm} = 694.4444$
Existing Column
New material: Steel Strength, $f_s = 1.25 * f_{sm} = 694.4444$

External Height, $H = 670.00$
External Width, $W = 400.00$
Internal Height, $H = 500.00$
Internal Width, $W = 200.00$
Cover Thickness, $c = 25.00$
Mean Confinement Factor overall section = 1.03245
Element Length, $L = 3000.00$
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length $l_o = 300.00$
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, $V_a = 9840.633$
EDGE -B-
Shear Force, $V_b = 9840.633$
BOTH EDGES
Axial Force, $F = -2237.255$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{sl,t} = 709.9999$
-Compression: $A_{sl,c} = 1668.186$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{sl,ten} = 709.9999$
-Compression: $A_{sl,com} = 1266.062$
-Middle: $A_{sl,mid} = 402.1239$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.2867466$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u * l_n / 2 = 160061.187$
with
 $M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 2.2533E+008$
 $M_{u1+} = 1.1683E+008$, 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
 $M_{u1-} = 2.2533E+008$, 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

$$M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 2.2533E+008$$

$M_{u2+} = 1.1683E+008$, 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

$M_{u2-} = 2.2533E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination

and

$$\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$$

with

$V_1 = 9840.633$, is the shear force acting at edge 1 for the static loading combination

$V_2 = 9840.633$, is the shear force acting at edge 2 for the static loading combination

Calculation of M_{u1+}

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

$$\phi_u = 6.1426221E-006$$

$$M_u = 1.1683E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.00650344$$

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

$$\text{From (5.4b), TBDY: } \phi_u = 0.00650344$$

$$w_e \text{ (5.4c)} = 0.00563792$$

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

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

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

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh, \min} \cdot F_{ywe} = \text{Min}(p_{sh, x} \cdot F_{ywe}, p_{sh, y} \cdot F_{ywe}) = 1.25907$$

 $p_{sh, x} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{s2} \cdot F_{ywe2} = 2.25221$

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

$$A_{sh1} = A_{stir_1} \cdot n_{s_1} = 157.0796$$

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

$$h_1 = 670.00$$

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

$$A_{sh2} = A_{stir_2} \cdot n_{s_2} = 100.531$$

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

$$h_2 = 500.00$$

 $p_{sh, y} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{s2} \cdot F_{ywe2} = 1.25907$

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

$$A_{sh1} = A_{stir_1} \cdot n_{s_1} = 157.0796$$

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

$$h_1 = 400.00$$

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

$$A_{sh2} = A_{stir_2} \cdot n_{s_2} = 100.531$$

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

$$h_2 = 200.00$$

 $A_{sec} = 268000.00$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.4444$$

$$fy_{we2} = 694.4444$$

$$f_{ce} = 33.00$$

From ((5.A.5), TBDY), TBDY: $cc = 0.00232446$

$$c = \text{confinement factor} = 1.03245$$

$$y_1 = 0.00097781$$

$$sh_1 = 0.003129$$

$$ft_1 = 325.9374$$

$$fy_1 = 271.6145$$

$$su_1 = 0.003129$$

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

$$lo/lou, \min = lb/ld = 0.17502824$$

$$su_1 = 0.4 * esu_{1, \text{nominal}} ((5.5), \text{TBDY}) = 0.032$$

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.

$$\text{with } fs_1 = (fs_{\text{jacket}} * Asl, \text{ten, jacket} + fs_{\text{core}} * Asl, \text{ten, core}) / Asl, \text{ten} = 271.6145$$

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

$$y_2 = 0.00097781$$

$$sh_2 = 0.003129$$

$$ft_2 = 325.9374$$

$$fy_2 = 271.6145$$

$$su_2 = 0.003129$$

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

$$lo/lou, \min = lb/lb, \min = 0.17502824$$

$$su_2 = 0.4 * esu_{2, \text{nominal}} ((5.5), \text{TBDY}) = 0.032$$

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.

$$\text{with } fs_2 = (fs_{\text{jacket}} * Asl, \text{com, jacket} + fs_{\text{core}} * Asl, \text{com, core}) / Asl, \text{com} = 271.6145$$

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

$$y_v = 0.00097781$$

$$sh_v = 0.003129$$

$$ft_v = 325.9374$$

$$fy_v = 271.6145$$

$$suv = 0.003129$$

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

$$lo/lou, \min = lb/ld = 0.17502824$$

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

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

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

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

$$\text{with } fsv = (fs_{\text{jacket}} * Asl, \text{mid, jacket} + fs_{\text{mid}} * Asl, \text{mid, core}) / Asl, \text{mid} = 271.6145$$

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

$$1 = Asl, \text{ten} / (b * d) * (fs_1 / f_c) = 0.02330074$$

$$2 = Asl, \text{com} / (b * d) * (fs_2 / f_c) = 0.04154956$$

$$v = Asl, \text{mid} / (b * d) * (fsv / f_c) = 0.01319688$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc (5A.2, \text{TBDY}) = 34.07072$$

$$cc (5A.5, \text{TBDY}) = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$1 = Asl, \text{ten} / (b * d) * (fs_1 / f_c) = 0.02879016$$

$$2 = Asl, \text{com} / (b * d) * (fs_2 / f_c) = 0.0513382$$

$$v = Asl, \text{mid} / (b * d) * (fsv / f_c) = 0.01630593$$

Case/Assumption: Unconfinedsd full section - Steel rupture

satisfies Eq. (4.3)

--->

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

--->

$$s_u(4.9) = 0.18757351$$

$$M_u = MR_c(4.14) = 1.1683E+008$$

$$u = s_u(4.1) = 6.1426221E-006$$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.17502824$

$$l_b = 300.00$$

$$l_d = 1714.009$$

Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$d_b = 15.23077$$

$$\text{Mean strength value of all re-bars: } f_y = 694.4444$$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of M_u1 -

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

$$u = 6.3198187E-006$$

$$M_u = 2.2533E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00650344$$

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

$$\text{From (5.4b), TBDY: } c_u = 0.00650344$$

$$w_e(5.4c) = 0.00563792$$

$$\text{ase}((5.4d), \text{TBDY}) = (\text{ase}_1 * A_{ext} + \text{ase}_2 * A_{int}) / A_{sec} = 0.14776895$$

$$\text{ase}_1 = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i_1} = 975400.00$$

$$\text{ase}_2 = \text{Max}(\text{ase}_1, \text{ase}_2) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i_2} = 557856.00$$

$$p_{sh,min} * F_{ywe} = \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.25907$$

$$p_{sh,x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.25221$$

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h2 = 500.00$$

$$\begin{aligned} \text{psh}_y * \text{Fywe} &= \text{psh}_1 * \text{Fywe}_1 + \text{ps}_2 * \text{Fywe}_2 = 1.25907 \\ \text{ps}_1 \text{ (external)} &= (\text{Ash}_1 * h_1 / s_1) / \text{Asec} = 0.00156298 \\ \text{Ash}_1 &= \text{Astir}_1 * \text{ns}_1 = 157.0796 \\ &\text{No stirups, ns}_1 = 2.00 \\ h_1 &= 400.00 \\ \text{ps}_2 \text{ (internal)} &= (\text{Ash}_2 * h_2 / s_2) / \text{Asec} = 0.00025008 \\ \text{Ash}_2 &= \text{Astir}_2 * \text{ns}_2 = 100.531 \\ &\text{No stirups, ns}_2 = 2.00 \\ h_2 &= 200.00 \end{aligned}$$

$$\text{Asec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$\text{fywe}_1 = 694.4444$$

$$\text{fywe}_2 = 694.4444$$

$$\text{fce} = 33.00$$

$$\text{From } ((5.A.5), \text{ TBDY}), \text{ TBDY: } cc = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$y_1 = 0.00097781$$

$$sh_1 = 0.003129$$

$$ft_1 = 325.9374$$

$$fy_1 = 271.6145$$

$$su_1 = 0.003129$$

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

$$lo/lou, \text{min} = lb/ld = 0.17502824$$

$$su_1 = 0.4 * \text{esu}_1 \text{ nominal } ((5.5), \text{ TBDY}) = 0.032$$

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

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

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

$$\text{with } fs_1 = (fs_{\text{jacket}} * \text{Asl,ten,jacket} + fs_{\text{core}} * \text{Asl,ten,core}) / \text{Asl,ten} = 271.6145$$

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

$$y_2 = 0.00097781$$

$$sh_2 = 0.003129$$

$$ft_2 = 325.9374$$

$$fy_2 = 271.6145$$

$$su_2 = 0.003129$$

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

$$lo/lou, \text{min} = lb/lb, \text{min} = 0.17502824$$

$$su_2 = 0.4 * \text{esu}_2 \text{ nominal } ((5.5), \text{ TBDY}) = 0.032$$

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

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

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

$$\text{with } fs_2 = (fs_{\text{jacket}} * \text{Asl,com,jacket} + fs_{\text{core}} * \text{Asl,com,core}) / \text{Asl,com} = 271.6145$$

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

$$y_v = 0.00097781$$

$$sh_v = 0.003129$$

$$ft_v = 325.9374$$

$$fy_v = 271.6145$$

$$suv = 0.003129$$

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

$$lo/lou, \text{min} = lb/ld = 0.17502824$$

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

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

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

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

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

with $f_{sv} = (f_{s,jacket} \cdot A_{sl,mid,jacket} + f_{s,mid} \cdot A_{sl,mid,core}) / A_{sl,mid} = 271.6145$
with $E_{sv} = (E_{s,jacket} \cdot A_{sl,mid,jacket} + E_{s,mid} \cdot A_{sl,mid,core}) / A_{sl,mid} = 200000.00$
 $1 = A_{sl,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.04154956$
 $2 = A_{sl,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.02330074$
 $v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.01319688$

and confined core properties:

$b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 34.07072$
 $cc (5A.5, TBDY) = 0.00232446$
 $c = \text{confinement factor} = 1.03245$
 $1 = A_{sl,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.0513382$
 $2 = A_{sl,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.02879016$
 $v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.01630593$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$su (4.9) = 0.21035251$
 $Mu = MRc (4.14) = 2.2533E+008$
 $u = su (4.1) = 6.3198187E-006$

Calculation of ratio l_b / l_d

Lap Length: $l_b / l_d = 0.17502824$

$l_b = 300.00$
 $l_d = 1714.009$

Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$= 1$
 $db = 15.23077$
Mean strength value of all re-bars: $f_y = 694.4444$
 $t = 1.16154$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.64216$
 $n = 13.00$

Calculation of Mu_{2+}

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

$u = 6.1426221E-006$
 $Mu = 1.1683E+008$

with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.00027032$
 $N = 2237.255$
 $f_c = 33.00$
 $co (5A.5, TBDY) = 0.002$
Final value of cu : $cu^* = \text{shear_factor} \cdot \text{Max}(cu, cc) = 0.00650344$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $cu = 0.00650344$
 $w_e (5.4c) = 0.00563792$
 $ase ((5.4d), TBDY) = (ase1 \cdot A_{ext} + ase2 \cdot A_{int}) / A_{sec} = 0.14776895$
 $ase1 = 0.14776895$
 $bo_1 = 340.00$

ho_1 = 610.00
bi2_1 = 975400.00
ase2 = Max(ase1,ase2) = 0.14776895
bo_2 = 192.00
ho_2 = 492.00
bi2_2 = 557856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.25907

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.25221
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.25907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 268000.00
s1 = 150.00
s2 = 300.00
fywe1 = 694.4444
fywe2 = 694.4444
fce = 33.00

From ((5.A.5), TBDY), TBDY: cc = 0.00232446
c = confinement factor = 1.03245

y1 = 0.00097781
sh1 = 0.003129
ft1 = 325.9374
fy1 = 271.6145
su1 = 0.003129

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

lo/lou,min = lb/lb,min = 0.17502824
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,min)^ 2/3), from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 271.6145

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

y2 = 0.00097781
sh2 = 0.003129
ft2 = 325.9374
fy2 = 271.6145
su2 = 0.003129

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

lo/lou,min = lb/lb,min = 0.17502824
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,min)^ 2/3), from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 271.6145

with $E_{s2} = (E_{s,jacket} \cdot A_{s,com,jacket} + E_{s,core} \cdot A_{s,com,core}) / A_{s,com} = 200000.00$
 $y_v = 0.00097781$
 $sh_v = 0.003129$
 $ft_v = 325.9374$
 $fy_v = 271.6145$
 $su_v = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{o,min} = l_b/l_d = 0.17502824$
 $su_v = 0.4 \cdot esuv_nominal((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fs_v = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fs_v = fsv/1.2$, 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 $fsv = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 271.6145$
 with $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.02330074$
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.04154956$
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.01319688$

and confined core properties:

$b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $f_{cc}(5A.2, TBDY) = 34.07072$
 $cc(5A.5, TBDY) = 0.00232446$
 $c = \text{confinement factor} = 1.03245$
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.02879016$
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.0513382$
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.01630593$

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

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su(4.9) = 0.18757351$
 $Mu = MRc(4.14) = 1.1683E+008$
 $u = su(4.1) = 6.1426221E-006$

 Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.17502824$
 $l_b = 300.00$
 $l_d = 1714.009$
 Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 15.23077$
 Mean strength value of all re-bars: $fy = 694.4444$
 $t = 1.16154$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.64216$
 $n = 13.00$

 Calculation of Mu_2 -

 Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 6.3198187E-006$
 $Mu = 2.2533E+008$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00650344$$

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

$$\text{From (5.4b), TBDY: } c_u = 0.00650344$$

$$w_e (5.4c) = 0.00563792$$

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

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

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

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25907$$

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.25221$$

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.25907$$

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.4444$$

$$f_{ywe2} = 694.4444$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A.5), TBDY), TBDY: } c_c = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$y_1 = 0.00097781$$

$$sh_1 = 0.003129$$

$$ft_1 = 325.9374$$

$$fy_1 = 271.6145$$

$$su_1 = 0.003129$$

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

$$l_o / l_{ou, \min} = l_b / d = 0.17502824$$

$$su_1 = 0.4 * esu_{1, \text{nominal}} ((5.5), TBDY) = 0.032$$

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

For calculation of $esu_{1, \text{nominal}}$ and y_1, sh_1, ft_1, fy_1 , it is considered characteristic value $fsy_1 = fs_1 / 1.2$, from table 5.1, TBDY.

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

$$\text{with } fs_1 = (fs_{\text{jacket}} * A_{sl, \text{ten, jacket}} + fs_{\text{core}} * A_{sl, \text{ten, core}}) / A_{sl, \text{ten}} = 271.6145$$

with $E_{s1} = (E_{s,jacket} \cdot A_{s,ten,jacket} + E_{s,core} \cdot A_{s,ten,core}) / A_{s,ten} = 200000.00$
 $y_2 = 0.00097781$
 $sh_2 = 0.003129$
 $ft_2 = 325.9374$
 $fy_2 = 271.6145$
 $su_2 = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_0/l_{ou,min} = l_b/l_{b,min} = 0.17502824$
 $su_2 = 0.4 \cdot esu_{2,nominal} ((5.5), TBDY) = 0.032$
 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 $fs_2 = fs_2/1.2$, 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 $fs_2 = (fs_{jacket} \cdot A_{s,com,jacket} + fs_{core} \cdot A_{s,com,core}) / A_{s,com} = 271.6145$
 with $E_{s2} = (E_{s,jacket} \cdot A_{s,com,jacket} + E_{s,core} \cdot A_{s,com,core}) / A_{s,com} = 200000.00$
 $y_v = 0.00097781$
 $sh_v = 0.003129$
 $ft_v = 325.9374$
 $fy_v = 271.6145$
 $suv = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_0/l_{ou,min} = l_b/l_d = 0.17502824$
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fs_v = fs_v/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fs_v = fs_v/1.2$, 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 $fs_v = (fs_{jacket} \cdot A_{s,mid,jacket} + fs_{mid} \cdot A_{s,mid,core}) / A_{s,mid} = 271.6145$
 with $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$
 $1 = A_{s,ten} / (b \cdot d) \cdot (fs_1 / f_c) = 0.04154956$
 $2 = A_{s,com} / (b \cdot d) \cdot (fs_2 / f_c) = 0.02330074$
 $v = A_{s,mid} / (b \cdot d) \cdot (fs_v / f_c) = 0.01319688$

and confined core properties:

$b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 34.07072$
 $cc (5A.5, TBDY) = 0.00232446$
 $c = \text{confinement factor} = 1.03245$
 $1 = A_{s,ten} / (b \cdot d) \cdot (fs_1 / f_c) = 0.0513382$
 $2 = A_{s,com} / (b \cdot d) \cdot (fs_2 / f_c) = 0.02879016$
 $v = A_{s,mid} / (b \cdot d) \cdot (fs_v / f_c) = 0.01630593$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

---->

$v < v_s, y_2$ - LHS eq.(4.5) is satisfied

---->

$su (4.9) = 0.21035251$
 $M_u = MR_c (4.14) = 2.2533E+008$
 $u = su (4.1) = 6.3198187E-006$

 Calculation of ratio l_b/l_d

 Lap Length: $l_b/l_d = 0.17502824$

$l_b = 300.00$

$l_d = 1714.009$

Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

$db = 15.23077$

Mean strength value of all re-bars: $fy = 694.4444$

t = 1.16154
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.64216
n = 13.00

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 558197.326$

Calculation of Shear Strength at edge 1, $V_{r1} = 558197.326$
 $V_{r1} = V_n$ ((22.5.1.1), ACI 318-14)

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

From Table (22.5.5.1), ACI 318-14: $V_c = 209131.476$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot \text{Area}_{jacket} + f'_{c_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 33.00$, but $f'_c^{0.5} \leq 8.3$
MPa (22.5.3.1, ACI 318-14)

$\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 400.00$
 $d = 536.00$
 $V_u \cdot d / \mu < 1 = 1.00$
 $\mu = 1.0197E+006$
 $V_u = 9840.633$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 349065.85$

$V_{s1} = 311832.16$ is calculated for jacket, with:

$d = 536.00$
 $A_v = 157079.633$
 $f_y = 555.5556$
 $s = 150.00$

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

$V_{s2} = 37233.691$ is calculated for jacket, with:

$d_2 = 400.00$
 $A_v = 100530.965$
 $f_y = 555.5556$
 $s = 300.00$

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

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

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

From (11-11), ACI 440: $V_s + V_f \leq 818179.336$

Calculation of Shear Strength at edge 2, $V_{r2} = 558197.326$
 $V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

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

From Table (22.5.5.1), ACI 318-14: $V_c = 209131.476$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot \text{Area}_{jacket} + f'_{c_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 33.00$, but $f'_c^{0.5} \leq 8.3$
MPa (22.5.3.1, ACI 318-14)

$\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 400.00$
 $d = 536.00$
 $V_u \cdot d / \mu < 1 = 1.00$
 $\mu = 1.0197E+006$
 $V_u = 9840.633$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 349065.85$

$V_{s1} = 311832.16$ is calculated for jacket, with:

$d = 536.00$
 $A_v = 157079.633$

fy = 555.5556

s = 150.00

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

Vs2 = 37233.691 is calculated for jacket, with:

d = 400.00

Av = 100530.965

fy = 555.5556

s = 300.00

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

2(1-s/d) = 0.50

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

From (11-11), ACI 440: Vs + Vf <= 818179.336

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

At local axis: 3

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

At Shear local axis: 2

(Bending local axis: 3)

Section Type: rcjars

Constant Properties

Knowledge Factor, = 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 = 555.5556

Concrete Elasticity, Ec = 26999.444

Steel Elasticity, Es = 200000.00

Existing Column

New material of Secondary Member: Concrete Strength, fc = fcm = 33.00

New material of Secondary Member: Steel Strength, fs = fsm = 555.5556

Concrete Elasticity, Ec = 26999.444

Steel Elasticity, Es = 200000.00

#####

Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

New material: Steel Strength, fs = 1.25*fsm = 694.4444

Existing Column

New material: Steel Strength, fs = 1.25*fsm = 694.4444

#####

External Height, H = 670.00

External Width, W = 400.00

Internal Height, H = 500.00

Internal Width, W = 200.00

Cover Thickness, c = 25.00

Mean Confinement Factor overall section = 1.03245

Element Length, L = 3000.00

Secondary Member

Smooth Bars

Ductile Steel

With Detailing for Earthquake Resistance (including stirrups closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length lo = 300.00

No FRP Wrapping

Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force, $V_a = -2.6375953E-014$

EDGE -B-

Shear Force, $V_b = 2.6375953E-014$

BOTH EDGES

Axial Force, $F = -2237.255$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{st} = 709.9999$

-Compression: $A_{sc} = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{st,ten} = 911.0619$

-Compression: $A_{sc,com} = 911.0619$

-Middle: $A_{st,mid} = 556.0619$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.15892241$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 60903.823$

with

$M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 9.1356E+007$

$M_{u1+} = 9.1356E+007$, 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

$M_{u1-} = 9.1356E+007$, 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

$M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 9.1356E+007$

$M_{u2+} = 9.1356E+007$, 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

$M_{u2-} = 9.1356E+007$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination

and

$\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$

with

$V_1 = -2.6375953E-014$, is the shear force acting at edge 1 for the static loading combination

$V_2 = 2.6375953E-014$, is the shear force acting at edge 2 for the static loading combination

Calculation of M_{u1+}

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

$\phi_u = 1.1029765E-005$

$M_u = 9.1356E+007$

with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.00028344$

$N = 2237.255$

$f_c = 33.00$

ϕ_c (5A.5, TBDY) = 0.002

Final value of ϕ_u : $\phi_u^* = \text{shear_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.00650344$

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

From (5.4b), TBDY: $\phi_u = 0.00650344$

w_e (5.4c) = 0.00563792

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

$a_{se1} = 0.14776895$

$bo_1 = 340.00$

$ho_1 = 610.00$

$bi2_1 = 975400.00$

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

$bo_2 = 192.00$

$ho_2 = 492.00$

$bi2_2 = 557856.00$

$psh_{min} \cdot F_{ywe} = \text{Min}(psh_x \cdot F_{ywe}, psh_y \cdot F_{ywe}) = 1.25907$

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.25221
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.25907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.4444

fywe2 = 694.4444

fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00232446

c = confinement factor = 1.03245

y1 = 0.00097781

sh1 = 0.003129

ft1 = 325.9374

fy1 = 271.6145

su1 = 0.003129

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

lo/lou,min = lb/ld = 0.17502824

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 $\text{Min}(1, 1.25 * (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 271.6145

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

y2 = 0.00097781

sh2 = 0.003129

ft2 = 325.9374

fy2 = 271.6145

su2 = 0.003129

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

lo/lou,min = lb/lb,min = 0.17502824

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 $\text{Min}(1, 1.25 * (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 271.6145

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

yv = 0.00097781

shv = 0.003129

ftv = 325.9374

fyv = 271.6145

suv = 0.003129

using (30) in Biskinis/Fardis (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/d = 0.17502824

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

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

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

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

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

with fsv = (fsjacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 271.6145

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

1 = Asl,ten/(b*d)*(fs1/fc) = 0.03135046

2 = Asl,com/(b*d)*(fs2/fc) = 0.03135046

v = Asl,mid/(b*d)*(fsv/fc) = 0.01913459

and confined core properties:

b = 610.00

d = 327.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07072

cc (5A.5, TBDY) = 0.00232446

c = confinement factor = 1.03245

1 = Asl,ten/(b*d)*(fs1/fc) = 0.0375932

2 = Asl,com/(b*d)*(fs2/fc) = 0.0375932

v = Asl,mid/(b*d)*(fsv/fc) = 0.02294481

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

su (4.9) = 0.20535904

Mu = MRc (4.14) = 9.1356E+007

u = su (4.1) = 1.1029765E-005

Calculation of ratio lb/d

Lap Length: lb/d = 0.17502824

lb = 300.00

ld = 1714.009

Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

db = 15.23077

Mean strength value of all re-bars: fy = 694.4444

t = 1.16154

s = 0.80

e = 1.00

cb = 25.00

Ktr = 2.64216

n = 13.00

Calculation of Mu1-

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

u = 1.1029765E-005

Mu = 9.1356E+007

with full section properties:

b = 670.00

d = 357.00

d' = 43.00

v = 0.00028344

N = 2237.255

fc = 33.00

co (5A.5, TBDY) = 0.002

Final value of cu: $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00650344$

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

From (5.4b), TBDY: $cu = 0.00650344$

we (5.4c) = 0.00563792

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

ase1 = 0.14776895

bo_1 = 340.00

ho_1 = 610.00

bi2_1 = 975400.00

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

bo_2 = 192.00

ho_2 = 492.00

bi2_2 = 557856.00

$psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.25907$

$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.25221$

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

Ash1 = Astir_1 * ns_1 = 157.0796

No stirups, ns_1 = 2.00

h1 = 670.00

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

Ash2 = Astir_2 * ns_2 = 100.531

No stirups, ns_2 = 2.00

h2 = 500.00

$psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.25907$

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

Ash1 = Astir_1 * ns_1 = 157.0796

No stirups, ns_1 = 2.00

h1 = 400.00

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

Ash2 = Astir_2 * ns_2 = 100.531

No stirups, ns_2 = 2.00

h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.4444

fywe2 = 694.4444

fce = 33.00

From ((5.A5), TBDY), TBDY: $cc = 0.00232446$

c = confinement factor = 1.03245

y1 = 0.00097781

sh1 = 0.003129

ft1 = 325.9374

fy1 = 271.6145

su1 = 0.003129

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

lo/lou,min = lb/ld = 0.17502824

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 $fs1 = (fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 271.6145$

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

y2 = 0.00097781

sh2 = 0.003129

ft2 = 325.9374

fy2 = 271.6145

su2 = 0.003129

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

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.17502824

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 = 271.6145

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

yv = 0.00097781

shv = 0.003129

ftv = 325.9374

fyv = 271.6145

suv = 0.003129

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

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/ld = 0.17502824

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

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

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

For calculation of esuv_nominal and yv, shv,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 = 271.6145

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

1 = Asl,ten/(b*d)*(fs1/fc) = 0.03135046

2 = Asl,com/(b*d)*(fs2/fc) = 0.03135046

v = Asl,mid/(b*d)*(fsv/fc) = 0.01913459

and confined core properties:

b = 610.00

d = 327.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07072

cc (5A.5, TBDY) = 0.00232446

c = confinement factor = 1.03245

1 = Asl,ten/(b*d)*(fs1/fc) = 0.0375932

2 = Asl,com/(b*d)*(fs2/fc) = 0.0375932

v = Asl,mid/(b*d)*(fsv/fc) = 0.02294481

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

su (4.9) = 0.20535904

Mu = MRc (4.14) = 9.1356E+007

u = su (4.1) = 1.1029765E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.17502824

lb = 300.00

ld = 1714.009

Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

db = 15.23077

Mean strength value of all re-bars: fy = 694.4444

t = 1.16154

s = 0.80

e = 1.00

cb = 25.00

Ktr = 2.64216

n = 13.00

Calculation of Mu2+

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

$$\mu = 1.1029765E-005$$

$$Mu = 9.1356E+007$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00650344$$

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

$$\text{From (5.4b), TBDY: } c_u = 0.00650344$$

$$w_e \text{ (5.4c)} = 0.00563792$$

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

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

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

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25907$$

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.25221$$

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

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

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

$$h_1 = 670.00$$

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

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

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

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.25907$$

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

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

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

$$h_1 = 400.00$$

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

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

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

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.4444$$

$$f_{ywe2} = 694.4444$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } c_c = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$y_1 = 0.00097781$$

$$sh_1 = 0.003129$$

$$ft_1 = 325.9374$$

$$fy_1 = 271.6145$$

$$su_1 = 0.003129$$

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.17502824

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 $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{d})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 271.6145

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

y2 = 0.00097781

sh2 = 0.003129

ft2 = 325.9374

fy2 = 271.6145

su2 = 0.003129

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

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.17502824

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 $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{d})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 271.6145

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

yv = 0.00097781

shv = 0.003129

ftv = 325.9374

fyv = 271.6145

suv = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.17502824

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

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

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

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

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

with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 271.6145

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

1 = Asl,ten/(b*d)*(fs1/fc) = 0.03135046

2 = Asl,com/(b*d)*(fs2/fc) = 0.03135046

v = Asl,mid/(b*d)*(fsv/fc) = 0.01913459

and confined core properties:

b = 610.00

d = 327.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07072

cc (5A.5, TBDY) = 0.00232446

c = confinement factor = 1.03245

1 = Asl,ten/(b*d)*(fs1/fc) = 0.0375932

2 = Asl,com/(b*d)*(fs2/fc) = 0.0375932

v = Asl,mid/(b*d)*(fsv/fc) = 0.02294481

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

su (4.9) = 0.20535904

Mu = MRc (4.14) = 9.1356E+007

u = su (4.1) = 1.1029765E-005

Calculation of ratio lb/d

Lap Length: $l_b/l_d = 0.17502824$

$l_b = 300.00$

$l_d = 1714.009$

Calculation of l_b, \min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

l_d, \min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$= 1$

$db = 15.23077$

Mean strength value of all re-bars: $f_y = 694.4444$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

Calculation of μ_2 -

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

$\mu = 1.1029765E-005$

$\mu = 9.1356E+007$

with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.00028344$

$N = 2237.255$

$f_c = 33.00$

α (5A.5, TBDY) = 0.002

Final value of μ : $\mu^* = \text{shear_factor} * \text{Max}(\mu_c, \mu_{cc}) = 0.00650344$

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

From (5.4b), TBDY: $\mu_c = 0.00650344$

μ_{cc} (5.4c) = 0.00563792

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

$\alpha_{se1} = 0.14776895$

$b_{o,1} = 340.00$

$h_{o,1} = 610.00$

$b_{i,1} = 975400.00$

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

$b_{o,2} = 192.00$

$h_{o,2} = 492.00$

$b_{i,2} = 557856.00$

$\text{psh}_{\min} * F_{ywe} = \text{Min}(\text{psh}_{x,1} * F_{ywe}, \text{psh}_{y,1} * F_{ywe}) = 1.25907$

$\text{psh}_x * F_{ywe} = \text{psh}_1 * F_{ywe1} + \text{ps}_2 * F_{ywe2} = 2.25221$

ps_1 (external) = $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$

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

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

$h_1 = 670.00$

ps_2 (internal) = $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$

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

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

$h_2 = 500.00$

$\text{psh}_y * F_{ywe} = \text{psh}_1 * F_{ywe1} + \text{ps}_2 * F_{ywe2} = 1.25907$

ps_1 (external) = $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$

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

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

$h_1 = 400.00$

ps_2 (internal) = $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$

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

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

h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.4444

fywe2 = 694.4444

fce = 33.00

From ((5.A.5), TBDY), TBDY: cc = 0.00232446

c = confinement factor = 1.03245

y1 = 0.00097781

sh1 = 0.003129

ft1 = 325.9374

fy1 = 271.6145

su1 = 0.003129

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

lo/lou,min = lb/lb = 0.17502824

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 = 271.6145

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

y2 = 0.00097781

sh2 = 0.003129

ft2 = 325.9374

fy2 = 271.6145

su2 = 0.003129

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

lo/lou,min = lb/lb,min = 0.17502824

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 = 271.6145

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

yv = 0.00097781

shv = 0.003129

ftv = 325.9374

fyv = 271.6145

suv = 0.003129

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

lo/lou,min = lb/lb = 0.17502824

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

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

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,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 = 271.6145

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

1 = Asl,ten/(b*d)*(fs1/fc) = 0.03135046

2 = Asl,com/(b*d)*(fs2/fc) = 0.03135046

v = Asl,mid/(b*d)*(fsv/fc) = 0.01913459

and confined core properties:

b = 610.00

d = 327.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07072

cc (5A.5, TBDY) = 0.00232446
c = confinement factor = 1.03245
1 = $Asl_{ten}/(b*d)*(fs1/fc) = 0.0375932$
2 = $Asl_{com}/(b*d)*(fs2/fc) = 0.0375932$
v = $Asl_{mid}/(b*d)*(fsv/fc) = 0.02294481$

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

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

---->
su (4.9) = 0.20535904
Mu = MRc (4.14) = 9.1356E+007
u = su (4.1) = 1.1029765E-005

Calculation of ratio lb/l_d

Lap Length: lb/l_d = 0.17502824

lb = 300.00

l_d = 1714.009

Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

l_{d,min} from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

db = 15.23077

Mean strength value of all re-bars: fy = 694.4444

t = 1.16154

s = 0.80

e = 1.00

cb = 25.00

K_{tr} = 2.64216

n = 13.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 383229.931

Calculation of Shear Strength at edge 1, Vr1 = 383229.931

Vr1 = V_n ((22.5.1.1), ACI 318-14)

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

From Table (22.5.5.1), ACI 318-14: V_c = 197061.477

= 1 (normal-weight concrete)

Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc'^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)

pw = As/(bw*d) = 0.00331157

As (tension reinf.) = 709.9999

bw = 670.00

d = 320.00

Vu*d/Mu < 1 = 0.00

Mu = 2.6257021E-011

Vu = 2.6375953E-014

From (11.5.4.8), ACI 318-14: Vs1 + Vs2 = 186168.454

Vs1 = 186168.454 is calculated for jacket, with:

d = 320.00

Av = 157079.633

fy = 555.5556

s = 150.00

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

Vs2 = 0.00 is calculated for jacket, with:

d2 = 160.00

Av = 100530.965

fy = 555.5556

s = 300.00

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

Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f \leq 818179.336$

Calculation of Shear Strength at edge 2, $V_{r2} = 383229.931$
 $V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

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

From Table (22.5.5.1), ACI 318-14: $V_c = 197061.477$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c_jacket} * Area_jacket + f'_{c_core} * Area_core) / Area_section = 33.00$, but $f_c^{0.5} \leq 8.3$
MPa (22.5.3.1, ACI 318-14)

$p_w = A_s / (b_w * d) = 0.00331157$
As (tension reinf.) = 709.9999
bw = 670.00
d = 320.00

$V_u * d / \mu_u < 1 = 0.00$
 $\mu_u = 5.2870952E-011$
 $V_u = 2.6375953E-014$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 186168.454$
 $V_{s1} = 186168.454$ is calculated for jacket, with:

d = 320.00
 $A_v = 157079.633$
fy = 555.5556
s = 150.00

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 0.00$ is calculated for jacket, with:

d = 160.00
 $A_v = 100530.965$
fy = 555.5556
s = 300.00

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

Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f \leq 818179.336$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rcjars

Constant Properties

Knowledge Factor, = 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, $f_s = f_{sm} = 555.5556$
Concrete Elasticity, $E_c = 26999.444$
Steel Elasticity, $E_s = 200000.00$

Existing Column

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.5556$
Concrete Elasticity, $E_c = 26999.444$
Steel Elasticity, $E_s = 200000.00$

External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00

Cover Thickness, $c = 25.00$
Element Length, $L = 3000.00$
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length $l_b = 300.00$
No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 1.2067021E-010$
Shear Force, $V_2 = -1.0300085E-013$
Shear Force, $V_3 = 18821.484$
Axial Force, $F = -4363.489$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{st} = 709.9999$
-Compression: $A_{sc} = 1668.186$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{st,ten} = 911.0619$
-Compression: $A_{sc,com} = 911.0619$
-Middle: $A_{sc,mid} = 556.0619$
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{st,ten,jacket} = 603.1858$
-Compression: $A_{sc,com,jacket} = 603.1858$
-Middle: $A_{sc,mid,jacket} = 402.1239$
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{st,ten,core} = 307.8761$
-Compression: $A_{sc,com,core} = 307.8761$
-Middle: $A_{sc,mid,core} = 153.938$
Mean Diameter of Tension Reinforcement, $DbL = 15.20$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_{,R} = 1.0^*$ $u = 0.00656885$
 $u = y + p = 0.00656885$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.00156885$ ((4.29), Biskinis Phd))
 $M_y = 9.0816E+007$
 $L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 1500.00
From table 10.5, ASCE 41_17: $E_{eff} = 0.3 * E_c * I_g = 2.8943E+013$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$
 $y_{ten} = 4.5526113E-006$
with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25 * f_y * (l_b / d)^{2/3}) = 252.1446$
 $d = 357.00$
 $y = 0.22430531$
 $A = 0.01001501$
 $B = 0.00564247$
with $pt = 0.00380895$
 $pc = 0.00380895$
 $pv = 0.00232477$
 $N = 4363.489$
 $b = 670.00$
 $" = 0.12044818$

y_comp = 2.7617879E-005
with fc = 33.00
Ec = 26999.444
y = 0.22313777
A = 0.0099012
B = 0.00557012
with Es = 200000.00

Calculation of ratio lb/l_d

Lap Length: l_d/l_{d,min} = 0.2187853

l_b = 300.00

l_d = 1371.207

Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

l_{d,min} from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)

= 1

db = 15.23077

Mean strength value of all re-bars: f_y = 555.5556

t = 1.16154

s = 0.80

e = 1.00

cb = 25.00

K_{tr} = 2.64216

n = 13.00

- Calculation of p -

From table 10-7: p = 0.005

with:

- Condition iv occurred

Beam controlled by inadequate embedment into beam-column joint:

(l_b/l_d < 1 and With Lapping in the Vicinity of the End Regions

- Condition i occurred

Beam controlled by flexure: V_p/V_o ≤ 1

shear control ratio V_p/V_o = 0.15892241

- Transverse Reinforcement: NC

- Stirrup Spacing > d/3

- Low ductility demand, λ / y < 2 (table 10-6, ASCE 41-17)

= -7.9248188E-022

- Stirrup Spacing ≤ d/2

d = d_{external} = 357.00

s = s_{external} = 150.00

- Strength provided by hoops V_s < 3/4*design Shear

V_s = 215955.406, already given in calculation of shear control ratio

design Shear = 1.0300085E-013

- (- ')/ bal = -0.23508642

= A_{st}/(b_w*d) = 0.00296835

Tension Reinf Area: A_{st} = 709.9999

' = A_{sc}/(b_w*d) = 0.00697431

Compression Reinf Area: A_{sc} = 1668.186

From (B-1), ACI 318-11: bal = 0.01704038

fc = (fc_{jacket}*Area_{jacket}+ fc_{core}*Area_{core})/section_area = 33.00

f_y = f_{y,jacket_bars} = 555.5556

From 10.2.7.3, ACI 318-11: λ = 0.65

From fig R10.3.3, ACI 318-11 (Ence 454, too): 87000/(87000+ f_y) = c_b/d_t = 0.003/(0.003+ λ) = 0.51923077

y = 0.00277778

- V/(b_w*d*fc^{0.5}) = 9.0274287E-019, NOTE: units in lb & in

b_w = 670.00

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

At local axis: 3

Integration Section: (b)

Calculation No. 9

beam B1, Floor 1

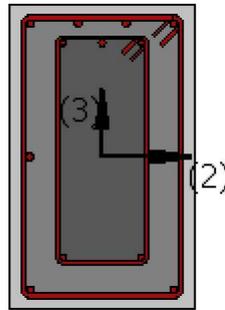
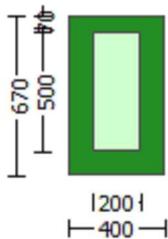
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (2)



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

At local axis: 2

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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

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, $E_s = 200000.00$

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length $l_o = l_b = 300.00$
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, $M_a = 2.3048016E-010$
Shear Force, $V_a = 1.2862848E-013$
EDGE -B-
Bending Moment, $M_b = 1.5504614E-010$
Shear Force, $V_b = -1.2862848E-013$
BOTH EDGES
Axial Force, $F = -4784.664$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{st} = 709.9999$
-Compression: $A_{sc} = 1668.186$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{s,ten} = 911.0619$
-Compression: $A_{s,com} = 911.0619$
-Middle: $A_{s,mid} = 556.0619$
Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 15.20$

New component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = 1.0 * V_n = 339071.608$
 V_n ((22.5.1.1), ACI 318-14) = 339071.608

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

From Table (22.5.5.1), ACI 318-14: $V_c = 171520.00$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_c_{jacket} * Area_{jacket} + f'_c_{core} * Area_{core}) / Area_{section} = 25.00$, but $f'_c^{0.5} \leq 8.3$
MPa ((22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w * d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 670.00$
 $d = 320.00$
 $V_u * d / M_u < 1 = 0.00$
 $M_u = 2.3048016E-010$
 $V_u = 1.2862848E-013$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 167551.608$
 $V_{s1} = 167551.608$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 500.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 0.00$ is calculated for core, with:
 $d = 160.00$
 $A_v = 100530.965$
 $f_y = 500.00$
 $s = 300.00$
 V_{s2} is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)
 V_f ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f \leq 712133.705$

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

Calculation No. 10

beam B1, Floor 1

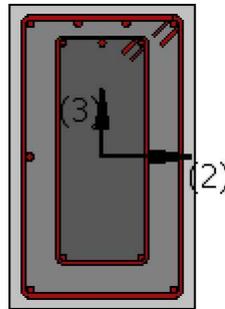
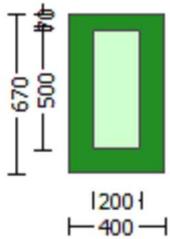
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (θ)

Edge: Start

Local Axis: (2)



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

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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, $f_s = f_{sm} = 555.5556$

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Existing Column

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

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.5556$

Concrete Elasticity, $E_c = 26999.444$

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, $f_s = 1.25 \cdot f_{sm} = 694.4444$

Existing Column

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 694.4444$

#####

External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03245
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length l_o = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, V_a = 9840.633
EDGE -B-
Shear Force, V_b = 9840.633
BOTH EDGES
Axial Force, F = -2237.255
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{sl,t}$ = 709.9999
-Compression: $A_{sl,c}$ = 1668.186
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{sl,ten}$ = 709.9999
-Compression: $A_{sl,com}$ = 1266.062
-Middle: $A_{sl,mid}$ = 402.1239

Calculation of Shear Capacity ratio , V_e/V_r = 0.2867466
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n / 2 = 160061.187$
with
 $M_{pr1} = \text{Max}(Mu_{1+} , Mu_{1-}) = 2.2533E+008$
 $Mu_{1+} = 1.1683E+008$, 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
 $Mu_{1-} = 2.2533E+008$, 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
 $M_{pr2} = \text{Max}(Mu_{2+} , Mu_{2-}) = 2.2533E+008$
 $Mu_{2+} = 1.1683E+008$, 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
 $Mu_{2-} = 2.2533E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination
and
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$
with
 $V_1 = 9840.633$, is the shear force acting at edge 1 for the the static loading combination
 $V_2 = 9840.633$, is the shear force acting at edge 2 for the the static loading combination

Calculation of Mu_{1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 6.1426221E-006$
 $Mu = 1.1683E+008$

with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.00027032$
 $N = 2237.255$
 $f_c = 33.00$
 $c_o (5A.5, TBDY) = 0.002$
 Final value of c_u : $c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00650344$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $c_u = 0.00650344$
 $w_e (5.4c) = 0.00563792$
 $a_{se} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$
 $a_{se1} = 0.14776895$
 $b_{o_1} = 340.00$
 $h_{o_1} = 610.00$
 $b_{i2_1} = 975400.00$
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$
 $b_{o_2} = 192.00$
 $h_{o_2} = 492.00$
 $b_{i2_2} = 557856.00$
 $p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25907$

$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.25221$
 $p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirups, $n_{s_1} = 2.00$
 $h_1 = 670.00$
 $p_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirups, $n_{s_2} = 2.00$
 $h_2 = 500.00$

$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.25907$
 $p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirups, $n_{s_1} = 2.00$
 $h_1 = 400.00$
 $p_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirups, $n_{s_2} = 2.00$
 $h_2 = 200.00$

$A_{sec} = 268000.00$
 $s_1 = 150.00$
 $s_2 = 300.00$
 $f_{ywe1} = 694.4444$
 $f_{ywe2} = 694.4444$
 $f_{ce} = 33.00$

From ((5.A5), TBDY), TBDY: $c_c = 0.00232446$
 $c = \text{confinement factor} = 1.03245$

$y_1 = 0.00097781$
 $sh_1 = 0.003129$
 $ft_1 = 325.9374$
 $fy_1 = 271.6145$
 $su_1 = 0.003129$

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

$l_o / l_{ou, \min} = l_b / d = 0.17502824$
 $su_1 = 0.4 * e_{su1_nominal} ((5.5), TBDY) = 0.032$

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 $f_{sy1} = f_{s1} / 1.2$, from table 5.1, TBDY.

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

with $f_{s1} = (f_{s, \text{jacket}} * A_{s1, \text{ten, jacket}} + f_{s, \text{core}} * A_{s1, \text{ten, core}}) / A_{s1, \text{ten}}$ = 271.6145

with $E_{s1} = (E_{s, \text{jacket}} * A_{s1, \text{ten, jacket}} + E_{s, \text{core}} * A_{s1, \text{ten, core}}) / A_{s1, \text{ten}}$ = 200000.00

$y_2 = 0.00097781$

$sh_2 = 0.003129$
 $ft_2 = 325.9374$
 $fy_2 = 271.6145$
 $su_2 = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lo_{min} = lb/lb_{min} = 0.17502824$
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$
 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 $fs_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = (fs_{jacket} * Asl_{com,jacket} + fs_{core} * Asl_{com,core}) / Asl_{com} = 271.6145$
 with $Es_2 = (Es_{jacket} * Asl_{com,jacket} + Es_{core} * Asl_{com,core}) / Asl_{com} = 200000.00$
 $yv = 0.00097781$
 $shv = 0.003129$
 $ftv = 325.9374$
 $fyv = 271.6145$
 $suv = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lo_{min} = lb/ld = 0.17502824$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and yv, shv, ftv, fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs_{jacket} * Asl_{mid,jacket} + fs_{mid} * Asl_{mid,core}) / Asl_{mid} = 271.6145$
 with $Es_v = (Es_{jacket} * Asl_{mid,jacket} + Es_{mid} * Asl_{mid,core}) / Asl_{mid} = 200000.00$
 $1 = Asl_{ten} / (b * d) * (fs_1 / fc) = 0.02330074$
 $2 = Asl_{com} / (b * d) * (fs_2 / fc) = 0.04154956$
 $v = Asl_{mid} / (b * d) * (fsv / fc) = 0.01319688$

and confined core properties:

$b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 34.07072$
 $cc (5A.5, TBDY) = 0.00232446$
 $c = \text{confinement factor} = 1.03245$
 $1 = Asl_{ten} / (b * d) * (fs_1 / fc) = 0.02879016$
 $2 = Asl_{com} / (b * d) * (fs_2 / fc) = 0.0513382$
 $v = Asl_{mid} / (b * d) * (fsv / fc) = 0.01630593$

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

--->
 $v < v_{s,y_2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.18757351$
 $Mu = MRc (4.14) = 1.1683E+008$
 $u = su (4.1) = 6.1426221E-006$

 Calculation of ratio lb/ld

 Lap Length: $lb/ld = 0.17502824$
 $lb = 300.00$
 $ld = 1714.009$
 Calculation of lb_{min} according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 ld_{min} from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 15.23077$
 Mean strength value of all re-bars: $fy = 694.4444$
 $t = 1.16154$
 $s = 0.80$

e = 1.00
cb = 25.00
Ktr = 2.64216
n = 13.00

Calculation of Mu1-

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

$u = 6.3198187E-006$
 $Mu = 2.2533E+008$

with full section properties:

b = 400.00
d = 627.00
d' = 43.00
v = 0.00027032
N = 2237.255
fc = 33.00
co (5A.5, TBDY) = 0.002

Final value of c_u : $c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00650344$
The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $c_u = 0.00650344$

w_e (5.4c) = 0.00563792

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

$a_{se1} = 0.14776895$

$b_{o_1} = 340.00$

$h_{o_1} = 610.00$

$b_{i2_1} = 975400.00$

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

$b_{o_2} = 192.00$

$h_{o_2} = 492.00$

$b_{i2_2} = 557856.00$

$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25907$

 $p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.25221$

$ps1$ (external) = $(A_{sh1} * h1 / s1) / A_{sec} = 0.00261799$

$A_{sh1} = A_{stir_1} * ns_1 = 157.0796$

No stirups, $ns_1 = 2.00$

$h1 = 670.00$

$ps2$ (internal) = $(A_{sh2} * h2 / s2) / A_{sec} = 0.00062519$

$A_{sh2} = A_{stir_2} * ns_2 = 100.531$

No stirups, $ns_2 = 2.00$

$h2 = 500.00$

 $p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.25907$

$ps1$ (external) = $(A_{sh1} * h1 / s1) / A_{sec} = 0.00156298$

$A_{sh1} = A_{stir_1} * ns_1 = 157.0796$

No stirups, $ns_1 = 2.00$

$h1 = 400.00$

$ps2$ (internal) = $(A_{sh2} * h2 / s2) / A_{sec} = 0.00025008$

$A_{sh2} = A_{stir_2} * ns_2 = 100.531$

No stirups, $ns_2 = 2.00$

$h2 = 200.00$

 $A_{sec} = 268000.00$

$s1 = 150.00$

$s2 = 300.00$

$f_{ywe1} = 694.4444$

$f_{ywe2} = 694.4444$

$f_{ce} = 33.00$

From ((5.A5), TBDY), TBDY: $cc = 0.00232446$

$c = \text{confinement factor} = 1.03245$

$y1 = 0.00097781$

$sh1 = 0.003129$
 $ft1 = 325.9374$
 $fy1 = 271.6145$
 $su1 = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou,min = lb/ld = 0.17502824$
 $su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032$
 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 $fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 271.6145$
 with $Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00$
 $y2 = 0.00097781$
 $sh2 = 0.003129$
 $ft2 = 325.9374$
 $fy2 = 271.6145$
 $su2 = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou,min = lb/lb,min = 0.17502824$
 $su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032$
 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 $fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 271.6145$
 with $Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00$
 $yv = 0.00097781$
 $shv = 0.003129$
 $ftv = 325.9374$
 $fyv = 271.6145$
 $suv = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou,min = lb/ld = 0.17502824$
 $suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv, shv, 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 $fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 271.6145$
 with $Es_v = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.04154956$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.02330074$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.01319688$
 and confined core properties:
 $b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 34.07072$
 $cc (5A.5, TBDY) = 0.00232446$
 $c = \text{confinement factor} = 1.03245$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.0513382$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.02879016$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.01630593$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < vs,y2$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.21035251$

$$\begin{aligned} \mu &= M/R_c (4.14) = 2.2533E+008 \\ u &= s_u (4.1) = 6.3198187E-006 \end{aligned}$$

Calculation of ratio l_b/l_d

$$\text{Lap Length: } l_b/l_d = 0.17502824$$

$$l_b = 300.00$$

$$l_d = 1714.009$$

Calculation of l_b, min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

l_d, min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$d_b = 15.23077$$

$$\text{Mean strength value of all re-bars: } f_y = 694.4444$$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of μ_{2+}

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

$$u = 6.1426221E-006$$

$$\mu = 1.1683E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00650344$$

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

$$\text{From (5.4b), TBDY: } c_u = 0.00650344$$

$$w_e (5.4c) = 0.00563792$$

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

$$ase1 = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i_1} = 975400.00$$

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

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i_2} = 557856.00$$

$$psh_{\text{min}} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.25907$$

$$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.25221$$

$$ps1 (\text{external}) = (A_{sh1} * h1 / s1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * ns_1 = 157.0796$$

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

$$h1 = 670.00$$

$$ps2 (\text{internal}) = (A_{sh2} * h2 / s2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * ns_2 = 100.531$$

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

$$h2 = 500.00$$

$$psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.25907$$

$$ps1 (\text{external}) = (A_{sh1} * h1 / s1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * ns_1 = 157.0796$$

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

 $Asec = 268000.00$
 $s1 = 150.00$
 $s2 = 300.00$
 $fywe1 = 694.4444$
 $fywe2 = 694.4444$
 $fce = 33.00$

From ((5.A.5), TBDY), TBDY: $cc = 0.00232446$
 $c = \text{confinement factor} = 1.03245$

$y1 = 0.00097781$
 $sh1 = 0.003129$
 $ft1 = 325.9374$
 $fy1 = 271.6145$
 $su1 = 0.003129$

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

$lo/lou, \min = lb/ld = 0.17502824$
 $su1 = 0.4 \cdot esu1_nominal$ ((5.5), TBDY) = 0.032

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

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

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

with $fs1 = (fs_jacket \cdot Asl, \text{ten}, \text{jacket} + fs_core \cdot Asl, \text{ten}, \text{core}) / Asl, \text{ten} = 271.6145$

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

$y2 = 0.00097781$
 $sh2 = 0.003129$
 $ft2 = 325.9374$
 $fy2 = 271.6145$
 $su2 = 0.003129$

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

$lo/lou, \min = lb/lb, \min = 0.17502824$
 $su2 = 0.4 \cdot esu2_nominal$ ((5.5), TBDY) = 0.032

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

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

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

with $fs2 = (fs_jacket \cdot Asl, \text{com}, \text{jacket} + fs_core \cdot Asl, \text{com}, \text{core}) / Asl, \text{com} = 271.6145$

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

$yv = 0.00097781$
 $shv = 0.003129$
 $ftv = 325.9374$
 $fyv = 271.6145$
 $suv = 0.003129$

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

$lo/lou, \min = lb/ld = 0.17502824$
 $suv = 0.4 \cdot esuv_nominal$ ((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 $fsv = (fs_jacket \cdot Asl, \text{mid}, \text{jacket} + fs_mid \cdot Asl, \text{mid}, \text{core}) / Asl, \text{mid} = 271.6145$

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

$1 = Asl, \text{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.02330074$

$2 = Asl, \text{com} / (b \cdot d) \cdot (fs2 / fc) = 0.04154956$

$v = Asl, \text{mid} / (b \cdot d) \cdot (fsv / fc) = 0.01319688$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc \text{ (5A.2, TBDY)} = 34.07072$$

$$cc \text{ (5A.5, TBDY)} = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.02879016$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.0513382$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.01630593$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$$s_u \text{ (4.9)} = 0.18757351$$

$$M_u = MR_c \text{ (4.14)} = 1.1683E+008$$

$$u = s_u \text{ (4.1)} = 6.1426221E-006$$

Calculation of ratio l_b/d

Lap Length: $l_b/d = 0.17502824$

$$l_b = 300.00$$

$$l_d = 1714.009$$

Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$d_b = 15.23077$$

Mean strength value of all re-bars: $f_y = 694.4444$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of M_{u2} -

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

$$u = 6.3198187E-006$$

$$M_u = 2.2533E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

Final value of ϕ_u : $\phi_u^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.00650344$

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

From (5.4b), TBDY: $\phi_{cu} = 0.00650344$

$$\phi_{we} \text{ (5.4c)} = 0.00563792$$

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

$$\text{ase1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

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

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$bi2_2 = 557856.00$$
$$psh,min*Fywe = \text{Min}(psh,x*Fywe, psh,y*Fywe) = 1.25907$$

$$psh_x*Fywe = psh1*Fywe1 + ps2*Fywe2 = 2.25221$$
$$ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00261799$$
$$Ash1 = Astir_1*ns_1 = 157.0796$$
$$\text{No stirups, } ns_1 = 2.00$$
$$h1 = 670.00$$
$$ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00062519$$
$$Ash2 = Astir_2*ns_2 = 100.531$$
$$\text{No stirups, } ns_2 = 2.00$$
$$h2 = 500.00$$

$$psh_y*Fywe = psh1*Fywe1 + ps2*Fywe2 = 1.25907$$
$$ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00156298$$
$$Ash1 = Astir_1*ns_1 = 157.0796$$
$$\text{No stirups, } ns_1 = 2.00$$
$$h1 = 400.00$$
$$ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00025008$$
$$Ash2 = Astir_2*ns_2 = 100.531$$
$$\text{No stirups, } ns_2 = 2.00$$
$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 694.4444$$

$$fywe2 = 694.4444$$

$$fce = 33.00$$

$$\text{From } ((5.A.5), \text{ TBDY}), \text{ TBDY: } cc = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$y1 = 0.00097781$$

$$sh1 = 0.003129$$

$$ft1 = 325.9374$$

$$fy1 = 271.6145$$

$$su1 = 0.003129$$

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

$$lo/lou,min = lb/l_d = 0.17502824$$

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

$$\text{From table 5A.1, TBDY: } esu1_nominal = 0.08,$$

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

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

$$\text{with } fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 271.6145$$

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

$$y2 = 0.00097781$$

$$sh2 = 0.003129$$

$$ft2 = 325.9374$$

$$fy2 = 271.6145$$

$$su2 = 0.003129$$

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

$$lo/lou,min = lb/l_b,min = 0.17502824$$

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

$$\text{From table 5A.1, TBDY: } esu2_nominal = 0.08,$$

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

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

$$\text{with } fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 271.6145$$

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

$$yv = 0.00097781$$

$$shv = 0.003129$$

$$ftv = 325.9374$$

$$fyv = 271.6145$$

$$suv = 0.003129$$

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

$$lo/lou,min = lb/ld = 0.17502824$$

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

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

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

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

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

$$\text{with } fsv = (fs_jacket * Asl_mid_jacket + fs_mid * Asl_mid_core) / Asl_mid = 271.6145$$

$$\text{with } Esv = (Es_jacket * Asl_mid_jacket + Es_mid * Asl_mid_core) / Asl_mid = 200000.00$$

$$1 = Asl_ten / (b * d) * (fs1 / fc) = 0.04154956$$

$$2 = Asl_com / (b * d) * (fs2 / fc) = 0.02330074$$

$$v = Asl_mid / (b * d) * (fsv / fc) = 0.01319688$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 34.07072$$

$$cc (5A.5, TBDY) = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$1 = Asl_ten / (b * d) * (fs1 / fc) = 0.0513382$$

$$2 = Asl_com / (b * d) * (fs2 / fc) = 0.02879016$$

$$v = Asl_mid / (b * d) * (fsv / fc) = 0.01630593$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$$su (4.9) = 0.21035251$$

$$Mu = MRc (4.14) = 2.2533E+008$$

$$u = su (4.1) = 6.3198187E-006$$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.17502824$

$$lb = 300.00$$

$$ld = 1714.009$$

Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$db = 15.23077$$

$$\text{Mean strength value of all re-bars: } fy = 694.4444$$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$cb = 25.00$$

$$Ktr = 2.64216$$

$$n = 13.00$$

Calculation of Shear Strength $Vr = \text{Min}(Vr1, Vr2) = 558197.326$

Calculation of Shear Strength at edge 1, $Vr1 = 558197.326$

$$Vr1 = Vn ((22.5.1.1), \text{ACI } 318-14)$$

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

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

From Table (22.5.5.1), ACI 318-14: $Vc = 209131.476$

$$= 1 \text{ (normal-weight concrete)}$$

$$\text{Mean concrete strength: } fc' = (fc'_{jacket} * Area_{jacket} + fc'_{core} * Area_{core}) / Area_{section} = 33.00, \text{ but } fc'^{0.5} \leq 8.3$$

MPa (22.5.3.1, ACI 318-14)

$$pw = As/(bw*d) = 0.00331157$$

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

$$bw = 400.00$$

$$d = 536.00$$

$$Vu*d/Mu < 1 = 1.00$$

$$Mu = 1.0197E+006$$

$$Vu = 9840.633$$

From (11.5.4.8), ACI 318-14: $Vs1 + Vs2 = 349065.85$

$Vs1 = 311832.16$ is calculated for jacket, with:

$$d = 536.00$$

$$Av = 157079.633$$

$$fy = 555.5556$$

$$s = 150.00$$

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

$Vs2 = 37233.691$ is calculated for jacket, with:

$$d2 = 400.00$$

$$Av = 100530.965$$

$$fy = 555.5556$$

$$s = 300.00$$

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

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

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

$$\text{From (11-11), ACI 440: } Vs + Vf <= 818179.336$$

Calculation of Shear Strength at edge 2, $Vr2 = 558197.326$

$$Vr2 = Vn \text{ ((22.5.1.1), ACI 318-14)}$$

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

From Table (22.5.5.1), ACI 318-14: $Vc = 209131.476$

= 1 (normal-weight concrete)

Mean concrete strength: $fc' = (fc'_{\text{jacket}}*Area_{\text{jacket}} + fc'_{\text{core}}*Area_{\text{core}})/Area_{\text{section}} = 33.00$, but $fc'^{0.5} <= 8.3$
MPa (22.5.3.1, ACI 318-14)

$$pw = As/(bw*d) = 0.00331157$$

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

$$bw = 400.00$$

$$d = 536.00$$

$$Vu*d/Mu < 1 = 1.00$$

$$Mu = 1.0197E+006$$

$$Vu = 9840.633$$

From (11.5.4.8), ACI 318-14: $Vs1 + Vs2 = 349065.85$

$Vs1 = 311832.16$ is calculated for jacket, with:

$$d = 536.00$$

$$Av = 157079.633$$

$$fy = 555.5556$$

$$s = 150.00$$

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

$Vs2 = 37233.691$ is calculated for jacket, with:

$$d = 400.00$$

$$Av = 100530.965$$

$$fy = 555.5556$$

$$s = 300.00$$

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

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

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

$$\text{From (11-11), ACI 440: } Vs + Vf <= 818179.336$$

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

At local axis: 3

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

At Shear local axis: 2

(Bending local axis: 3)
Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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, $f_s = f_{sm} = 555.5556$

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Existing Column

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

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.5556$

Concrete Elasticity, $E_c = 26999.444$

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, $f_s = 1.25 \cdot f_{sm} = 694.4444$

Existing Column

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 694.4444$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.03245

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

With Detailing for Earthquake Resistance (including stirrups closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = 300.00$

No FRP Wrapping

Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force, $V_a = -2.6375953E-014$

EDGE -B-

Shear Force, $V_b = 2.6375953E-014$

BOTH EDGES

Axial Force, $F = -2237.255$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{sl,t} = 709.9999$

-Compression: $A_{sl,c} = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{sl,ten} = 911.0619$

-Compression: $A_{sl,com} = 911.0619$

-Middle: $A_{sl,mid} = 556.0619$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.15892241$

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

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 60903.823$

with

$M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 9.1356E+007$

Mu1+ = 9.1356E+007, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination

Mu1- = 9.1356E+007, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination

Mpr2 = Max(Mu2+ , Mu2-) = 9.1356E+007

Mu2+ = 9.1356E+007, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination

Mu2- = 9.1356E+007, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

and

$$\pm wu*ln = (|V1| + |V2|)/2$$

with

V1 = -2.6375953E-014, is the shear force acting at edge 1 for the the static loading combination

V2 = 2.6375953E-014, is the shear force acting at edge 2 for the the static loading combination

Calculation of Mu1+

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

$$u = 1.1029765E-005$$

$$Mu = 9.1356E+007$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$fc = 33.00$$

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

$$\text{Final value of } cu: cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00650344$$

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

$$\text{From (5.4b), TBDY: } cu = 0.00650344$$

$$we (5.4c) = 0.00563792$$

$$ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.14776895$$

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

$$ho_1 = 610.00$$

$$bi2_1 = 975400.00$$

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

$$bo_2 = 192.00$$

$$ho_2 = 492.00$$

$$bi2_2 = 557856.00$$

$$psh,min*Fywe = \text{Min}(psh,x*Fywe , psh,y*Fywe) = 1.25907$$

$$psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.25221$$

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

$$Ash1 = Astir_1*ns_1 = 157.0796$$

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

$$h1 = 670.00$$

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

$$Ash2 = Astir_2*ns_2 = 100.531$$

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

$$h2 = 500.00$$

$$psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.25907$$

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

$$Ash1 = Astir_1*ns_1 = 157.0796$$

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

$$h1 = 400.00$$

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

$$Ash2 = Astir_2*ns_2 = 100.531$$

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

$$h2 = 200.00$$

Asec = 268000.00
 s1 = 150.00
 s2 = 300.00
 fywe1 = 694.4444
 fywe2 = 694.4444
 fce = 33.00
 From ((5.A.5), TBDY), TBDY: cc = 0.00232446
 c = confinement factor = 1.03245
 y1 = 0.00097781
 sh1 = 0.003129
 ft1 = 325.9374
 fy1 = 271.6145
 su1 = 0.003129
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 lo/lou,min = lb/lb = 0.17502824
 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 $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.
 with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 271.6145
 with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
 y2 = 0.00097781
 sh2 = 0.003129
 ft2 = 325.9374
 fy2 = 271.6145
 su2 = 0.003129
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 lo/lou,min = lb/lb,min = 0.17502824
 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 $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.
 with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 271.6145
 with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
 yv = 0.00097781
 shv = 0.003129
 ftv = 325.9374
 fyv = 271.6145
 suv = 0.003129
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 lo/lou,min = lb/lb = 0.17502824
 suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
 From table 5A.1, TBDY: esuv_nominal = 0.08,
 considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
 For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
 characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
 y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.
 with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 271.6145
 with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
 1 = Asl,ten/(b*d)*(fs1/fc) = 0.03135046
 2 = Asl,com/(b*d)*(fs2/fc) = 0.03135046
 v = Asl,mid/(b*d)*(fsv/fc) = 0.01913459
 and confined core properties:
 b = 610.00
 d = 327.00
 d' = 13.00
 fcc (5A.2, TBDY) = 34.07072
 cc (5A.5, TBDY) = 0.00232446
 c = confinement factor = 1.03245

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.0375932$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.0375932$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.02294481$$

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

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

$$\text{su (4.9)} = 0.20535904$$

$$\text{Mu} = \text{MRc (4.14)} = 9.1356\text{E}+007$$

$$u = \text{su (4.1)} = 1.1029765\text{E}-005$$

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.17502824

$$lb = 300.00$$

$$ld = 1714.009$$

Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$db = 15.23077$$

Mean strength value of all re-bars: fy = 694.4444

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$cb = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of Mu1-

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

$$u = 1.1029765\text{E}-005$$

$$\text{Mu} = 9.1356\text{E}+007$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00650344
The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: cu = 0.00650344

$$w_e \text{ (5.4c)} = 0.00563792$$

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

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

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

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh,min}*F_{ywe} = \text{Min}(p_{sh,x}*F_{ywe}, p_{sh,y}*F_{ywe}) = 1.25907$$

$$p_{sh,x}*F_{ywe} = p_{sh1}*F_{ywe1}+p_{s2}*F_{ywe2} = 2.25221$$

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

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

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

h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.25907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 268000.00
s1 = 150.00
s2 = 300.00
fywe1 = 694.4444
fywe2 = 694.4444
fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00232446
c = confinement factor = 1.03245

y1 = 0.00097781
sh1 = 0.003129
ft1 = 325.9374
fy1 = 271.6145
su1 = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.17502824
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

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

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

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

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 271.6145

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

y2 = 0.00097781
sh2 = 0.003129
ft2 = 325.9374
fy2 = 271.6145
su2 = 0.003129

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

lo/lou,min = lb/lb,min = 0.17502824
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 = 271.6145

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

yv = 0.00097781
shv = 0.003129
ftv = 325.9374
fyv = 271.6145
suv = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.17502824
suv = 0.4*esuv_nominal ((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 $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 271.6145$

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

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.03135046$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.03135046$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.01913459$

and confined core properties:

$b = 610.00$

$d = 327.00$

$d' = 13.00$

f_{cc} (5A.2, TBDY) = 34.07072

cc (5A.5, TBDY) = 0.00232446

c = confinement factor = 1.03245

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.0375932$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.0375932$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.02294481$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

su (4.9) = 0.20535904

$\mu_u = MR_c$ (4.14) = 9.1356E+007

$u = su$ (4.1) = 1.1029765E-005

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.17502824$

$l_b = 300.00$

$l_d = 1714.009$

Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

$db = 15.23077$

Mean strength value of all re-bars: $f_y = 694.4444$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

Calculation of μ_{u2+}

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

$u = 1.1029765E-005$

$\mu_u = 9.1356E+007$

with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.00028344$

$N = 2237.255$

$f_c = 33.00$

co (5A.5, TBDY) = 0.002

Final value of cu : $cu^* = \text{shear_factor} \cdot \text{Max}(cu, cc) = 0.00650344$

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

From (5.4b), TBDY: $cu = 0.00650344$

we (5.4c) = 0.00563792
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.14776895
ase1 = 0.14776895
bo_1 = 340.00
ho_1 = 610.00
bi2_1 = 975400.00
ase2 = Max(ase1,ase2) = 0.14776895
bo_2 = 192.00
ho_2 = 492.00
bi2_2 = 557856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.25907

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.25221
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.25907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 268000.00
s1 = 150.00
s2 = 300.00

fywe1 = 694.4444
fywe2 = 694.4444
fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00232446
c = confinement factor = 1.03245

y1 = 0.00097781
sh1 = 0.003129
ft1 = 325.9374
fy1 = 271.6145
su1 = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.17502824

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

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

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

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

with fs1 = (fsjacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 271.6145

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

y2 = 0.00097781
sh2 = 0.003129
ft2 = 325.9374
fy2 = 271.6145
su2 = 0.003129

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

lo/lou,min = lb/lb,min = 0.17502824

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 $fs_2 = (fs_{jacket} \cdot A_{sl,com,jacket} + fs_{core} \cdot A_{sl,com,core}) / A_{sl,com} = 271.6145$

with $Es_2 = (Es_{jacket} \cdot A_{sl,com,jacket} + Es_{core} \cdot A_{sl,com,core}) / A_{sl,com} = 200000.00$

$y_v = 0.000977781$

$sh_v = 0.003129$

$ft_v = 325.9374$

$fy_v = 271.6145$

$s_{uv} = 0.003129$

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

$lo/lo_{u,min} = lb/ld = 0.17502824$

$s_{uv} = 0.4 \cdot es_{uv_nominal} ((5,5), TBDY) = 0.032$

From table 5A.1, TBDY: $es_{uv_nominal} = 0.08$,

considering characteristic value $fs_{yv} = f_{sv}/1.2$, from table 5.1, TBDY

For calculation of $es_{uv_nominal}$ and y_v , sh_v, ft_v, fy_v , it is considered characteristic value $fs_{yv} = f_{sv}/1.2$, from table 5.1, TBDY.

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

with $f_{sv} = (f_{s,jacket} \cdot A_{sl,mid,jacket} + f_{s,mid} \cdot A_{sl,mid,core}) / A_{sl,mid} = 271.6145$

with $Es_v = (Es_{jacket} \cdot A_{sl,mid,jacket} + Es_{mid} \cdot A_{sl,mid,core}) / A_{sl,mid} = 200000.00$

$1 = A_{sl,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.03135046$

$2 = A_{sl,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.03135046$

$v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.01913459$

and confined core properties:

$b = 610.00$

$d = 327.00$

$d' = 13.00$

$f_{cc} (5A.2, TBDY) = 34.07072$

$cc (5A.5, TBDY) = 0.00232446$

$c = \text{confinement factor} = 1.03245$

$1 = A_{sl,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.0375932$

$2 = A_{sl,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.0375932$

$v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.02294481$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$su (4.9) = 0.20535904$

$Mu = MRc (4.14) = 9.1356E+007$

$u = su (4.1) = 1.1029765E-005$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.17502824$

$lb = 300.00$

$ld = 1714.009$

Calculation of lb_{min} according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

ld_{min} from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

$db = 15.23077$

Mean strength value of all re-bars: $fy = 694.4444$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

Calculation of Mu_2 -

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

$$u = 1.1029765E-005$$

$$Mu = 9.1356E+007$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.00650344$$

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

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.00650344$$

$$\phi_{we} \text{ (5.4c)} = 0.00563792$$

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

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

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

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25907$$

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.25221$$

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

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

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

$$h_1 = 670.00$$

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

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.25907$$

$$p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.4444$$

$$f_{ywe2} = 694.4444$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_{cc} = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$y_1 = 0.00097781$$

$$sh_1 = 0.003129$$

$$ft_1 = 325.9374$$

$$fy_1 = 271.6145$$

$$su_1 = 0.003129$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$l_o / l_{o, \min} = l_b / d = 0.17502824$$

$$su_1 = 0.4 * esu_{1, \text{nominal}} \text{ ((5.5), TBDY)} = 0.032$$

From table 5A.1, TBDY: $esu_{1, \text{nominal}} = 0.08$,

For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs1 = (fs_{jacket} \cdot Asl_{ten,jacket} + fs_{core} \cdot Asl_{ten,core}) / Asl_{ten} = 271.6145$

with $Es1 = (Es_{jacket} \cdot Asl_{ten,jacket} + Es_{core} \cdot Asl_{ten,core}) / Asl_{ten} = 200000.00$

$$y2 = 0.00097781$$

$$sh2 = 0.003129$$

$$ft2 = 325.9374$$

$$fy2 = 271.6145$$

$$su2 = 0.003129$$

using (30) in Biskinis/Fardis (2013) multiplied with $shear_factor$ and also multiplied by the $shear_factor$ according to 15.7.1.4, with $Shear_factor = 1.00$

$$lo/lo_{ou,min} = lb/lb_{min} = 0.17502824$$

$$su2 = 0.4 \cdot esu2_nominal \text{ ((5.5), TBDY)} = 0.032$$

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 $Min(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs2 = (fs_{jacket} \cdot Asl_{com,jacket} + fs_{core} \cdot Asl_{com,core}) / Asl_{com} = 271.6145$

with $Es2 = (Es_{jacket} \cdot Asl_{com,jacket} + Es_{core} \cdot Asl_{com,core}) / Asl_{com} = 200000.00$

$$yv = 0.00097781$$

$$shv = 0.003129$$

$$ftv = 325.9374$$

$$fyv = 271.6145$$

$$suv = 0.003129$$

using (30) in Biskinis/Fardis (2013) multiplied with $shear_factor$ and also multiplied by the $shear_factor$ according to 15.7.1.4, with $Shear_factor = 1.00$

$$lo/lo_{ou,min} = lb/ld = 0.17502824$$

$$suv = 0.4 \cdot esuv_nominal \text{ ((5.5), TBDY)} = 0.032$$

From table 5A.1, TBDY: $esuv_nominal = 0.08$,

considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY

For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fsv = (fs_{jacket} \cdot Asl_{mid,jacket} + fs_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 271.6145$

with $Es_v = (Es_{jacket} \cdot Asl_{mid,jacket} + Es_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 200000.00$

$$1 = Asl_{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.03135046$$

$$2 = Asl_{com} / (b \cdot d) \cdot (fs2 / fc) = 0.03135046$$

$$v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.01913459$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$fcc \text{ (5A.2, TBDY)} = 34.07072$$

$$cc \text{ (5A.5, TBDY)} = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$1 = Asl_{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.0375932$$

$$2 = Asl_{com} / (b \cdot d) \cdot (fs2 / fc) = 0.0375932$$

$$v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.02294481$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < vs, y2$ - LHS eq.(4.5) is satisfied

--->

$$su \text{ (4.9)} = 0.20535904$$

$$Mu = MRc \text{ (4.14)} = 9.1356E+007$$

$$u = su \text{ (4.1)} = 1.1029765E-005$$

Calculation of ratio lb/ld

$$\text{Lap Length: } lb/ld = 0.17502824$$

$$lb = 300.00$$

$$ld = 1714.009$$

Calculation of lb_{min} according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

db = 15.23077

Mean strength value of all re-bars: fy = 694.4444

t = 1.16154

s = 0.80

e = 1.00

cb = 25.00

Ktr = 2.64216

n = 13.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 383229.931

Calculation of Shear Strength at edge 1, Vr1 = 383229.931

Vr1 = Vn ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: Vc = 197061.477

= 1 (normal-weight concrete)

Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc'^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)

pw = As/(bw*d) = 0.00331157

As (tension reinf.) = 709.9999

bw = 670.00

d = 320.00

Vu*d/Mu < 1 = 0.00

Mu = 2.6257021E-011

Vu = 2.6375953E-014

From (11.5.4.8), ACI 318-14: Vs1 + Vs2 = 186168.454

Vs1 = 186168.454 is calculated for jacket, with:

d = 320.00

Av = 157079.633

fy = 555.5556

s = 150.00

Vs1 has been multiplied by 1 (s<d/2, according to ASCE 41-17,10.3.4)

Vs2 = 0.00 is calculated for jacket, with:

d2 = 160.00

Av = 100530.965

fy = 555.5556

s = 300.00

Vs2 is considered 0 (s>d, according to ASCE 41-17,10.3.4)

Vf ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: Vs + Vf <= 818179.336

Calculation of Shear Strength at edge 2, Vr2 = 383229.931

Vr2 = Vn ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: Vc = 197061.477

= 1 (normal-weight concrete)

Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc'^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)

pw = As/(bw*d) = 0.00331157

As (tension reinf.) = 709.9999

bw = 670.00

d = 320.00

Vu*d/Mu < 1 = 0.00

Mu = 5.2870952E-011

Vu = 2.6375953E-014

From (11.5.4.8), ACI 318-14: Vs1 + Vs2 = 186168.454

Vs1 = 186168.454 is calculated for jacket, with:

d = 320.00

Av = 157079.633

fy = 555.5556

s = 150.00

Vs1 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

Vs2 = 0.00 is calculated for jacket, with:

d = 160.00

Av = 100530.965

fy = 555.5556

s = 300.00

Vs2 is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)

Vf ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: Vs + Vf <= 818179.336

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor, = 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, $f_s = f_{sm} = 555.5556$

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Existing Column

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 33.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.5556$

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

External Height, H = 670.00

External Width, W = 400.00

Internal Height, H = 500.00

Internal Width, W = 200.00

Cover Thickness, c = 25.00

Element Length, L = 3000.00

Secondary Member

Smooth Bars

Ductile Steel

With Detailing for Earthquake Resistance (including stirrups closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_b = 300.00$

No FRP Wrapping

Stepwise Properties

Bending Moment, M = 1.3438E+007

Shear Force, V2 = 1.2862848E-013

Shear Force, V3 = -919.1918

Axial Force, F = -4784.664

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: As_t = 709.9999

-Compression: As_c = 1668.186

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $Asl,ten = 709.9999$

-Compression: $Asl,com = 1266.062$

-Middle: $Asl,mid = 402.1239$

Longitudinal External Reinforcement Area Distribution (in 3 divisions)

-Tension: $Asl,ten,jacket = 402.1239$

-Compression: $Asl,com,jacket = 804.2477$

-Middle: $Asl,mid,jacket = 402.1239$

Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)

-Tension: $Asl,ten,core = 307.8761$

-Compression: $Asl,com,core = 461.8141$

-Middle: $Asl,mid,core = 0.00$

Mean Diameter of Tension Reinforcement, $DbL = 15.00$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u,R = 1.0^*$ $u = 0.02307899$

$u = y + p = 0.02307899$

- Calculation of y -

$y = (My * Ls / 3) / Eleff = 0.00307899$ ((4.29), Biskinis Phd)

$My = 1.2501E+008$

$Ls = M/V$ (with $Ls > 0.1 * L$ and $Ls < 2 * L$) = 6000.00

From table 10.5, ASCE 41_17: $Eleff = 0.3 * Ec * Ig = 8.1204E+013$

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$

$y_{ten} = 2.4698669E-006$

with ((10.1), ASCE 41-17) $fy = \text{Min}(fy, 1.25 * fy * (lb/d)^{2/3}) = 252.1446$

$d = 627.00$

$y = 0.18589856$

$A = 0.00955806$

$B = 0.00410947$

with $pt = 0.00283094$

$pc = 0.00504809$

$pv = 0.00160336$

$N = 4784.664$

$b = 400.00$

$" = 0.06858054$

$y_{comp} = 1.9034257E-005$

with $fc = 33.00$

$Ec = 26999.444$

$y = 0.18434363$

$A = 0.00943904$

$B = 0.0040338$

with $Es = 200000.00$

Calculation of ratio lb/d

Lap Length: $ld/d, min = 0.2187853$

$lb = 300.00$

$ld = 1371.207$

Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

ld, min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)

$= 1$

$db = 15.23077$

Mean strength value of all re-bars: $fy = 555.5556$

$t = 1.16154$

s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.64216
n = 13.00

- Calculation of ρ -

From table 10-7: $\rho = 0.02$

with:

- Condition iv occurred

Beam controlled by inadequate embedment into beam-column joint:
($l_b/d < 1$ and With Lapping in the Vicinity of the End Regions)

- Condition i occurred

Beam controlled by flexure: $V_p/V_o \leq 1$

shear control ratio $V_p/V_o = 0.2867466$

- Transverse Reinforcement: C

- Stirrup Spacing $\leq d/3$

- Low ductility demand, $\lambda / y < 2$ (table 10-6, ASCE 41-17)

= 6.9433622E-005

- Stirrup Spacing $\leq d/2$

d = d_external = 627.00

s = s_external = 150.00

- Strength provided by hoops $V_s < 3/4$ *design Shear

$V_s = 386299.541$, already given in calculation of shear control ratio

design Shear = 919.1918

- ($\rho - \rho'$)/ bal = -0.22420383

= $A_{st}/(b_w*d) = 0.00283094$

Tension Reinf Area: $A_{st} = 709.9999$

$\rho' = A_{sc}/(b_w*d) = 0.00665146$

Compression Reinf Area: $A_{sc} = 1668.186$

From (B-1), ACI 318-11: bal = 0.01704038

$f_c = (f_{c_jacket}*Area_jacket + f_{c_core}*Area_core)/section_area = 33.00$

$f_y = f_{y_jacket_bars} = 555.5556$

From 10.2.7.3, ACI 318-11: $\lambda = 0.65$

From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000/(87000 + f_y) = c_b/d_t = 0.003/(0.003 + y) = 0.51923077$

$y = 0.00277778$

- $V/(b_w*d*f_c^{0.5}) = 0.00768325$, NOTE: units in lb & in

$b_w = 400.00$

End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (a)

Calculation No. 11

beam B1, Floor 1

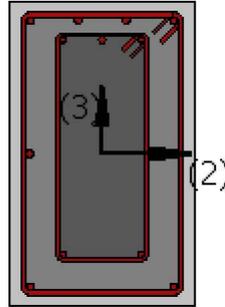
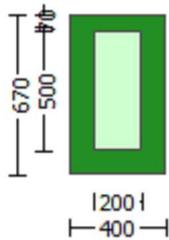
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (3)



Start Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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

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, $E_s = 200000.00$

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

With Detailing for Earthquake Resistance (including stirrups closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = l_b = 300.00$

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 1.3438E+007$
Shear Force, $V_a = -919.1918$
EDGE -B-
Bending Moment, $M_b = 1.8842E+007$
Shear Force, $V_b = 20600.458$
BOTH EDGES
Axial Force, $F = -4784.664$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{sl,t} = 709.9999$
-Compression: $A_{sl,c} = 1668.186$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{sl,ten} = 709.9999$
-Compression: $A_{sl,com} = 1266.062$
-Middle: $A_{sl,mid} = 402.1239$
Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 15.00$

New component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = 1.0 \cdot V_n = 486121.809$
 V_n ((22.5.1.1), ACI 318-14) = 486121.809

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw + f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 171962.543$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c,jacket} \cdot Area_{jacket} + f'_{c,core} \cdot Area_{core}) / Area_{section} = 25.00$, but $f_c^{0.5} \leq 8.3$
MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 400.00$
 $d = 536.00$
 $V_u \cdot d / \mu < 1 = 0.03666472$
 $\mu = 1.3438E+007$
 $V_u = 919.1918$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 314159.265$
 $V_{s1} = 280648.944$ is calculated for jacket, with:
 $d = 536.00$
 $A_v = 157079.633$
 $f_y = 500.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 33510.322$ is calculated for core, with:
 $d = 400.00$
 $A_v = 100530.965$
 $f_y = 500.00$
 $s = 300.00$
 V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
 V_f ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f \leq 712133.705$

End Of Calculation of Shear Capacity for element: beam JB1 of floor 1
At local axis: 3
Integration Section: (a)

Calculation No. 12

beam B1, Floor 1

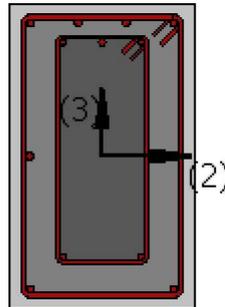
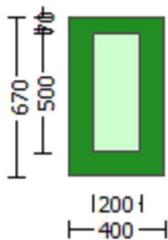
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (θ)

Edge: Start

Local Axis: (3)



Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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, $f_s = f_{sm} = 555.5556$

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Existing Column

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 33.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.5556$

Concrete Elasticity, $E_c = 26999.444$

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, $f_s = 1.25 \cdot f_{sm} = 694.4444$

Existing Column

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 694.4444$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$
Mean Confinement Factor overall section = 1.03245
Element Length, $L = 3000.00$
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length $l_o = 300.00$
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, $V_a = 9840.633$
EDGE -B-
Shear Force, $V_b = 9840.633$
BOTH EDGES
Axial Force, $F = -2237.255$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{sl,ten} = 709.9999$
-Compression: $A_{sl,com} = 1668.186$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{sl,ten} = 709.9999$
-Compression: $A_{sl,com} = 1266.062$
-Middle: $A_{sl,mid} = 402.1239$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.2867466$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 160061.187$
with
 $M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 2.2533E+008$
 $Mu_{1+} = 1.1683E+008$, 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
 $Mu_{1-} = 2.2533E+008$, 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
 $M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 2.2533E+008$
 $Mu_{2+} = 1.1683E+008$, 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
 $Mu_{2-} = 2.2533E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination
and
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$
with
 $V_1 = 9840.633$, is the shear force acting at edge 1 for the static loading combination
 $V_2 = 9840.633$, is the shear force acting at edge 2 for the static loading combination

Calculation of Mu_{1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 6.1426221E-006$
 $Mu = 1.1683E+008$

with full section properties:
 $b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.00027032$
 $N = 2237.255$

fc = 33.00

co (5A.5, TBDY) = 0.002

Final value of cu: $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00650344$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $cu = 0.00650344$

we (5.4c) = 0.00563792

ase ((5.4d), TBDY) = $(ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$

ase1 = 0.14776895

bo_1 = 340.00

ho_1 = 610.00

bi2_1 = 975400.00

ase2 = $\text{Max}(ase1, ase2) = 0.14776895$

bo_2 = 192.00

ho_2 = 492.00

bi2_2 = 557856.00

$psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.25907$

$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.25221$

ps1 (external) = $(Ash1 * h1 / s1) / A_{sec} = 0.00261799$

Ash1 = Astir_1 * ns_1 = 157.0796

No stirups, ns_1 = 2.00

h1 = 670.00

ps2 (internal) = $(Ash2 * h2 / s2) / A_{sec} = 0.00062519$

Ash2 = Astir_2 * ns_2 = 100.531

No stirups, ns_2 = 2.00

h2 = 500.00

$psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.25907$

ps1 (external) = $(Ash1 * h1 / s1) / A_{sec} = 0.00156298$

Ash1 = Astir_1 * ns_1 = 157.0796

No stirups, ns_1 = 2.00

h1 = 400.00

ps2 (internal) = $(Ash2 * h2 / s2) / A_{sec} = 0.00025008$

Ash2 = Astir_2 * ns_2 = 100.531

No stirups, ns_2 = 2.00

h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.4444

fywe2 = 694.4444

fce = 33.00

From ((5.A5), TBDY), TBDY: $cc = 0.00232446$

c = confinement factor = 1.03245

y1 = 0.00097781

sh1 = 0.003129

ft1 = 325.9374

fy1 = 271.6145

su1 = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 0.17502824

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 $fs1 = (fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 271.6145$

with $Es1 = (Es_{jacket} * A_{sl,ten,jacket} + Es_{core} * A_{sl,ten,core}) / A_{sl,ten} = 200000.00$

y2 = 0.00097781

sh2 = 0.003129

ft2 = 325.9374

fy2 = 271.6145

su2 = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.17502824

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 = 271.6145

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.00097781

shv = 0.003129

ftv = 325.9374

fyv = 271.6145

suv = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/ld = 0.17502824

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY

For calculation of esuv_nominal and yv, shv,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 = 271.6145

with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.02330074

2 = Asl,com/(b*d)*(fs2/fc) = 0.04154956

v = Asl,mid/(b*d)*(fsv/fc) = 0.01319688

and confined core properties:

b = 340.00

d = 597.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07072

cc (5A.5, TBDY) = 0.00232446

c = confinement factor = 1.03245

1 = Asl,ten/(b*d)*(fs1/fc) = 0.02879016

2 = Asl,com/(b*d)*(fs2/fc) = 0.0513382

v = Asl,mid/(b*d)*(fsv/fc) = 0.01630593

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

v < vs,y2 - LHS eq.(4.5) is satisfied

--->

su (4.9) = 0.18757351

Mu = MRc (4.14) = 1.1683E+008

u = su (4.1) = 6.1426221E-006

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.17502824

lb = 300.00

ld = 1714.009

Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

db = 15.23077

Mean strength value of all re-bars: fy = 694.4444

t = 1.16154

s = 0.80

e = 1.00

cb = 25.00

Ktr = 2.64216

n = 13.00

Calculation of Mu1-

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:

$$\mu = 6.3198187E-006$$

$$Mu = 2.2533E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$c_o \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00650344$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.00650344$$

$$w_e \text{ (5.4c)} = 0.00563792$$

$$a_{se} \text{ ((5.4d), TBDY)} = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25907$$

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.25221$$

$$p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.25907$$

$$p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.4444$$

$$f_{ywe2} = 694.4444$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } c_c = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$y_1 = 0.00097781$$

$$sh_1 = 0.003129$$

$$ft_1 = 325.9374$$

$$fy_1 = 271.6145$$

$$su_1 = 0.003129$$

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.17502824

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 $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 271.6145

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.00097781

sh2 = 0.003129

ft2 = 325.9374

fy2 = 271.6145

su2 = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.17502824

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 $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 271.6145

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.00097781

shv = 0.003129

ftv = 325.9374

fyv = 271.6145

suv = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.17502824

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY

For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 271.6145

with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.04154956

2 = Asl,com/(b*d)*(fs2/fc) = 0.02330074

v = Asl,mid/(b*d)*(fsv/fc) = 0.01319688

and confined core properties:

b = 340.00

d = 597.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07072

cc (5A.5, TBDY) = 0.00232446

c = confinement factor = 1.03245

1 = Asl,ten/(b*d)*(fs1/fc) = 0.0513382

2 = Asl,com/(b*d)*(fs2/fc) = 0.02879016

v = Asl,mid/(b*d)*(fsv/fc) = 0.01630593

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

v < vs,y2 - LHS eq.(4.5) is satisfied

--->

su (4.9) = 0.21035251

Mu = MRc (4.14) = 2.2533E+008

u = su (4.1) = 6.3198187E-006

Calculation of ratio lb/d

Lap Length: $l_b/l_d = 0.17502824$

$l_b = 300.00$

$l_d = 1714.009$

Calculation of l_b, \min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

l_d, \min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$= 1$

$db = 15.23077$

Mean strength value of all re-bars: $f_y = 694.4444$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

Calculation of μ_{2+}

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:

$\mu = 6.1426221E-006$

$\mu = 1.1683E+008$

with full section properties:

$b = 400.00$

$d = 627.00$

$d' = 43.00$

$v = 0.00027032$

$N = 2237.255$

$f_c = 33.00$

α (5A.5, TBDY) = 0.002

Final value of μ : $\mu^* = \text{shear_factor} * \text{Max}(\mu, \alpha) = 0.00650344$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $\mu = 0.00650344$

w_e (5.4c) = 0.00563792

a_{se} ((5.4d), TBDY) = $(a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$

$a_{se1} = 0.14776895$

$b_{o_1} = 340.00$

$h_{o_1} = 610.00$

$b_{i2_1} = 975400.00$

$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$

$b_{o_2} = 192.00$

$h_{o_2} = 492.00$

$b_{i2_2} = 557856.00$

$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25907$

$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.25221$

ps_1 (external) = $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$

$A_{sh1} = A_{stir_1} * ns_1 = 157.0796$

No stirups, $ns_1 = 2.00$

$h_1 = 670.00$

ps_2 (internal) = $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$

$A_{sh2} = A_{stir_2} * ns_2 = 100.531$

No stirups, $ns_2 = 2.00$

$h_2 = 500.00$

$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.25907$

ps_1 (external) = $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$

$A_{sh1} = A_{stir_1} * ns_1 = 157.0796$

No stirups, $ns_1 = 2.00$

$h_1 = 400.00$

ps_2 (internal) = $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$

$A_{sh2} = A_{stir_2} * ns_2 = 100.531$

No stirups, $ns_2 = 2.00$

h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.4444

fywe2 = 694.4444

fce = 33.00

From ((5.A.5), TBDY), TBDY: cc = 0.00232446

c = confinement factor = 1.03245

y1 = 0.00097781

sh1 = 0.003129

ft1 = 325.9374

fy1 = 271.6145

su1 = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 0.17502824

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 $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 271.6145

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.00097781

sh2 = 0.003129

ft2 = 325.9374

fy2 = 271.6145

su2 = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.17502824

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 $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 271.6145

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.00097781

shv = 0.003129

ftv = 325.9374

fyv = 271.6145

suv = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 0.17502824

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.

with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 271.6145

with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.02330074

2 = Asl,com/(b*d)*(fs2/fc) = 0.04154956

v = Asl,mid/(b*d)*(fsv/fc) = 0.01319688

and confined core properties:

b = 340.00

d = 597.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07072

$$cc \text{ (5A.5, TBDY)} = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.02879016$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.0513382$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.01630593$$

Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$$su \text{ (4.9)} = 0.18757351$$

$$Mu = MRc \text{ (4.14)} = 1.1683E+008$$

$$u = su \text{ (4.1)} = 6.1426221E-006$$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.17502824$

$$l_b = 300.00$$

$$l_d = 1714.009$$

Calculation of l_b ,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

l_d ,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$db = 15.23077$$

Mean strength value of all re-bars: $f_y = 694.4444$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$cb = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of Mu_2 -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$$u = 6.3198187E-006$$

$$Mu = 2.2533E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$co \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } cu: cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00650344$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } cu = 0.00650344$$

$$w_e \text{ (5.4c)} = 0.00563792$$

$$ase \text{ ((5.4d), TBDY)} = (ase1*A_{ext} + ase2*A_{int})/A_{sec} = 0.14776895$$

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

$$ho_1 = 610.00$$

$$bi2_1 = 975400.00$$

$$ase2 = \text{Max}(ase1, ase2) = 0.14776895$$

$$bo_2 = 192.00$$

$$ho_2 = 492.00$$

$$bi2_2 = 557856.00$$

$$psh_{,min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.25907$$

$$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.25221$$

$$ps1 \text{ (external)} = (A_{sh1} * h1 / s1) / A_{sec} = 0.00261799$$

Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.25907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 268000.00
s1 = 150.00
s2 = 300.00
fywe1 = 694.4444
fywe2 = 694.4444
fce = 33.00

From ((5.A.5), TBDY), TBDY: cc = 0.00232446
c = confinement factor = 1.03245

y1 = 0.00097781
sh1 = 0.003129
ft1 = 325.9374
fy1 = 271.6145
su1 = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.17502824

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 $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{l}_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 271.6145

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.00097781
sh2 = 0.003129
ft2 = 325.9374
fy2 = 271.6145
su2 = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.17502824

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 $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{l}_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 271.6145

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.00097781
shv = 0.003129
ftv = 325.9374
fyv = 271.6145
suv = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.17502824

$$suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esuv_nominal = 0.08$,

considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY

For calculation of $esuv_nominal$ and yv , shv, 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.

$$\text{with } fsv = (fs_jacket * Asl_mid_jacket + fs_mid * Asl_mid_core) / Asl_mid = 271.6145$$

$$\text{with } Esv = (Es_jacket * Asl_mid_jacket + Es_mid * Asl_mid_core) / Asl_mid = 200000.00$$

$$1 = Asl_ten / (b * d) * (fs1 / fc) = 0.04154956$$

$$2 = Asl_com / (b * d) * (fs2 / fc) = 0.02330074$$

$$v = Asl_mid / (b * d) * (fsv / fc) = 0.01319688$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 34.07072$$

$$cc (5A.5, TBDY) = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$1 = Asl_ten / (b * d) * (fs1 / fc) = 0.0513382$$

$$2 = Asl_com / (b * d) * (fs2 / fc) = 0.02879016$$

$$v = Asl_mid / (b * d) * (fsv / fc) = 0.01630593$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < vs, y2$ - LHS eq.(4.5) is satisfied

--->

$$su (4.9) = 0.21035251$$

$$Mu = MRc (4.14) = 2.2533E+008$$

$$u = su (4.1) = 6.3198187E-006$$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.17502824$

$$lb = 300.00$$

$$ld = 1714.009$$

Calculation of lb, min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

ld, min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$db = 15.23077$$

Mean strength value of all re-bars: $fy = 694.4444$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$cb = 25.00$$

$$Ktr = 2.64216$$

$$n = 13.00$$

Calculation of Shear Strength $Vr = Min(Vr1, Vr2) = 558197.326$

Calculation of Shear Strength at edge 1, $Vr1 = 558197.326$

$$Vr1 = Vn ((22.5.1.1), ACI 318-14)$$

NOTE: In expression (22.5.1.1) ' Vw ' is replaced by ' $Vw + f * Vf$ '

where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $Vc = 209131.476$

= 1 (normal-weight concrete)

Mean concrete strength: $fc' = (fc'_jacket * Area_jacket + fc'_core * Area_core) / Area_section = 33.00$, but $fc'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$$pw = As / (bw * d) = 0.00331157$$

$$As (\text{tension reinf.}) = 709.9999$$

$$bw = 400.00$$

$$d = 536.00$$

$$Vu*d/Mu < 1 = 1.00$$

$$Mu = 1.0197E+006$$

$$Vu = 9840.633$$

From (11.5.4.8), ACI 318-14: $Vs1 + Vs2 = 349065.85$

$Vs1 = 311832.16$ is calculated for jacket, with:

$$d = 536.00$$

$$Av = 157079.633$$

$$fy = 555.5556$$

$$s = 150.00$$

$Vs1$ has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$Vs2 = 37233.691$ is calculated for jacket, with:

$$d2 = 400.00$$

$$Av = 100530.965$$

$$fy = 555.5556$$

$$s = 300.00$$

$Vs2$ has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.50$$

$$Vf ((11-3)-(11.4), ACI 440) = 0.00$$

$$\text{From (11-11), ACI 440: } Vs + Vf \leq 818179.336$$

Calculation of Shear Strength at edge 2, $Vr2 = 558197.326$

$$Vr2 = Vn ((22.5.1.1), ACI 318-14)$$

NOTE: In expression (22.5.1.1) ' Vw ' is replaced by ' $Vw + f*Vf$ ' where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $Vc = 209131.476$

= 1 (normal-weight concrete)

Mean concrete strength: $fc' = (fc'_{\text{jacket}} * Area_{\text{jacket}} + fc'_{\text{core}} * Area_{\text{core}}) / Area_{\text{section}} = 33.00$, but $fc'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$$pw = As / (bw * d) = 0.00331157$$

$$As (\text{tension reinf.}) = 709.9999$$

$$bw = 400.00$$

$$d = 536.00$$

$$Vu*d/Mu < 1 = 1.00$$

$$Mu = 1.0197E+006$$

$$Vu = 9840.633$$

From (11.5.4.8), ACI 318-14: $Vs1 + Vs2 = 349065.85$

$Vs1 = 311832.16$ is calculated for jacket, with:

$$d = 536.00$$

$$Av = 157079.633$$

$$fy = 555.5556$$

$$s = 150.00$$

$Vs1$ has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$Vs2 = 37233.691$ is calculated for jacket, with:

$$d = 400.00$$

$$Av = 100530.965$$

$$fy = 555.5556$$

$$s = 300.00$$

$Vs2$ has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.50$$

$$Vf ((11-3)-(11.4), ACI 440) = 0.00$$

$$\text{From (11-11), ACI 440: } Vs + Vf \leq 818179.336$$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 2

(Bending local axis: 3)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 1.00$
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, $f_s = f_{sm} = 555.5556$
Concrete Elasticity, $E_c = 26999.444$
Steel Elasticity, $E_s = 200000.00$
Existing Column
New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.5556$
Concrete Elasticity, $E_c = 26999.444$
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, $f_s = 1.25 * f_{sm} = 694.4444$
Existing Column
New material: Steel Strength, $f_s = 1.25 * f_{sm} = 694.4444$

External Height, $H = 670.00$
External Width, $W = 400.00$
Internal Height, $H = 500.00$
Internal Width, $W = 200.00$
Cover Thickness, $c = 25.00$
Mean Confinement Factor overall section = 1.03245
Element Length, $L = 3000.00$
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length $l_o = 300.00$
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, $V_a = -2.6375953E-014$
EDGE -B-
Shear Force, $V_b = 2.6375953E-014$
BOTH EDGES
Axial Force, $F = -2237.255$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{st} = 709.9999$
-Compression: $A_{sc} = 1668.186$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{st,ten} = 911.0619$
-Compression: $A_{sl,com} = 911.0619$
-Middle: $A_{sl,mid} = 556.0619$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.15892241$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u * l_n / 2 = 60903.823$
with
 $M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 9.1356E+007$
 $M_{u1+} = 9.1356E+007$, 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
 $M_{u1-} = 9.1356E+007$, 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
 $M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 9.1356E+007$

$\mu_{2+} = 9.1356E+007$, 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

$\mu_{2-} = 9.1356E+007$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination
and

$$\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$$

with

$V_1 = -2.6375953E-014$, is the shear force acting at edge 1 for the the static loading combination

$V_2 = 2.6375953E-014$, is the shear force acting at edge 2 for the the static loading combination

Calculation of μ_{1+}

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:

$$\mu = 1.1029765E-005$$

$$\mu = 9.1356E+007$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$c_o \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } \mu: \mu^* = \text{shear_factor} \cdot \text{Max}(\mu, c_c) = 0.00650344$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \mu = 0.00650344$$

$$w_e \text{ (5.4c)} = 0.00563792$$

$$a_{se} \text{ ((5.4d), TBDY)} = (a_{se1} \cdot A_{ext} + a_{se2} \cdot A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o1} = 340.00$$

$$h_{o1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o2} = 192.00$$

$$h_{o2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh, \min} \cdot F_{ywe} = \text{Min}(p_{sh, x} \cdot F_{ywe}, p_{sh, y} \cdot F_{ywe}) = 1.25907$$

 $p_{sh, x} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{s2} \cdot F_{ywe2} = 2.25221$

$$p_{s1} \text{ (external)} = (A_{sh1} \cdot h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir, 1} \cdot n_{s, 1} = 157.0796$$

$$\text{No stirups, } n_{s, 1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} \cdot h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir, 2} \cdot n_{s, 2} = 100.531$$

$$\text{No stirups, } n_{s, 2} = 2.00$$

$$h_2 = 500.00$$

 $p_{sh, y} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{s2} \cdot F_{ywe2} = 1.25907$

$$p_{s1} \text{ (external)} = (A_{sh1} \cdot h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir, 1} \cdot n_{s, 1} = 157.0796$$

$$\text{No stirups, } n_{s, 1} = 2.00$$

$$h_1 = 400.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} \cdot h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir, 2} \cdot n_{s, 2} = 100.531$$

$$\text{No stirups, } n_{s, 2} = 2.00$$

$$h_2 = 200.00$$

 $A_{sec} = 268000.00$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.4444$$

$$f_{ywe2} = 694.4444$$

$f_{ce} = 33.00$
 From ((5.A.5), TBDY), TBDY: $cc = 0.00232446$
 $c = \text{confinement factor} = 1.03245$
 $y_1 = 0.00097781$
 $sh_1 = 0.003129$
 $ft_1 = 325.9374$
 $fy_1 = 271.6145$
 $su_1 = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou, \min = lb/ld = 0.17502824$
 $su_1 = 0.4 * esu_1 \text{ nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_1 \text{ nominal} = 0.08$,
 For calculation of $esu_1 \text{ nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered
 characteristic value $fsy_1 = fs_1/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_1 = (fs_{jacket} * Asl, \text{ten, jacket} + fs_{core} * Asl, \text{ten, core}) / Asl, \text{ten} = 271.6145$
 with $Es_1 = (Es_{jacket} * Asl, \text{ten, jacket} + Es_{core} * Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$
 $y_2 = 0.00097781$
 $sh_2 = 0.003129$
 $ft_2 = 325.9374$
 $fy_2 = 271.6145$
 $su_2 = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou, \min = lb/lb, \min = 0.17502824$
 $su_2 = 0.4 * esu_2 \text{ nominal} ((5.5), TBDY) = 0.032$
 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 $fs_2 = (fs_{jacket} * Asl, \text{com, jacket} + fs_{core} * Asl, \text{com, core}) / Asl, \text{com} = 271.6145$
 with $Es_2 = (Es_{jacket} * Asl, \text{com, jacket} + Es_{core} * Asl, \text{com, core}) / Asl, \text{com} = 200000.00$
 $y_v = 0.00097781$
 $sh_v = 0.003129$
 $ft_v = 325.9374$
 $fy_v = 271.6145$
 $suv = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou, \min = lb/ld = 0.17502824$
 $suv = 0.4 * esuv \text{ nominal} ((5.5), TBDY) = 0.032$
 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 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 $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs_{jacket} * Asl, \text{mid, jacket} + fs_{mid} * Asl, \text{mid, core}) / Asl, \text{mid} = 271.6145$
 with $Es_v = (Es_{jacket} * Asl, \text{mid, jacket} + Es_{mid} * Asl, \text{mid, core}) / Asl, \text{mid} = 200000.00$
 $1 = Asl, \text{ten} / (b * d) * (fs_1 / fc) = 0.03135046$
 $2 = Asl, \text{com} / (b * d) * (fs_2 / fc) = 0.03135046$
 $v = Asl, \text{mid} / (b * d) * (fsv / fc) = 0.01913459$
 and confined core properties:
 $b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 34.07072$
 $cc (5A.5, TBDY) = 0.00232446$
 $c = \text{confinement factor} = 1.03245$
 $1 = Asl, \text{ten} / (b * d) * (fs_1 / fc) = 0.0375932$
 $2 = Asl, \text{com} / (b * d) * (fs_2 / fc) = 0.0375932$
 $v = Asl, \text{mid} / (b * d) * (fsv / fc) = 0.02294481$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.20535904
Mu = MRc (4.14) = 9.1356E+007
u = su (4.1) = 1.1029765E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.17502824
lb = 300.00
ld = 1714.009
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
= 1
db = 15.23077
Mean strength value of all re-bars: fy = 694.4444
t = 1.16154
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.64216
n = 13.00

Calculation of Mu1-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 1.1029765E-005
Mu = 9.1356E+007

with full section properties:

b = 670.00
d = 357.00
d' = 43.00
v = 0.00028344
N = 2237.255
fc = 33.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00650344
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00650344
we (5.4c) = 0.00563792
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.14776895
ase1 = 0.14776895
bo_1 = 340.00
ho_1 = 610.00
bi_1 = 975400.00
ase2 = Max(ase1,ase2) = 0.14776895
bo_2 = 192.00
ho_2 = 492.00
bi_2 = 557856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.25907

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.25221
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = psh₁*Fywe₁+ps₂*Fywe₂ = 1.25907
ps₁ (external) = (Ash₁*h₁/s₁)/Asec = 0.00156298
Ash₁ = Astir₁*ns₁ = 157.0796
No stirups, ns₁ = 2.00
h₁ = 400.00
ps₂ (internal) = (Ash₂*h₂/s₂)/Asec = 0.00025008
Ash₂ = Astir₂*ns₂ = 100.531
No stirups, ns₂ = 2.00
h₂ = 200.00

Asec = 268000.00

s₁ = 150.00

s₂ = 300.00

fywe₁ = 694.4444

fywe₂ = 694.4444

fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00232446

c = confinement factor = 1.03245

y₁ = 0.00097781

sh₁ = 0.003129

ft₁ = 325.9374

fy₁ = 271.6145

su₁ = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.17502824

su₁ = 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 y₁, sh₁,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/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} = 271.6145

with Es₁ = (Es_{jacket}*Asl_{ten,jacket} + Es_{core}*Asl_{ten,core})/Asl_{ten} = 200000.00

y₂ = 0.00097781

sh₂ = 0.003129

ft₂ = 325.9374

fy₂ = 271.6145

su₂ = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with 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} = 0.17502824

su₂ = 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 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/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} = 271.6145

with Es₂ = (Es_{jacket}*Asl_{com,jacket} + Es_{core}*Asl_{com,core})/Asl_{com} = 200000.00

y_v = 0.00097781

sh_v = 0.003129

ft_v = 325.9374

fy_v = 271.6145

suv = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.17502824

suv = 0.4*esuv_{nominal} ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_{nominal} = 0.08,

considering characteristic value fsy_v = 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 fsy_v = fsv/1.2, from table 5.1, TBDY.

y₁, sh₁,ft₁,fy₁, are also multiplied by Min(1,1.25*(lb/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} = 271.6145

$$\text{with } E_{sv} = (E_{s,jacket} \cdot A_{sl,mid,jacket} + E_{s,mid} \cdot A_{sl,mid,core}) / A_{sl,mid} = 200000.00$$

$$1 = A_{sl,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.03135046$$

$$2 = A_{sl,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.03135046$$

$$v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.01913459$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 34.07072$$

$$c_c (5A.5, TBDY) = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$1 = A_{sl,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.0375932$$

$$2 = A_{sl,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.0375932$$

$$v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.02294481$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$$s_u (4.9) = 0.20535904$$

$$M_u = M_{Rc} (4.14) = 9.1356E+007$$

$$u = s_u (4.1) = 1.1029765E-005$$

Calculation of ratio l_b/d

Lap Length: $l_b/d = 0.17502824$

$$l_b = 300.00$$

$$l_d = 1714.009$$

Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$d_b = 15.23077$$

Mean strength value of all re-bars: $f_y = 694.4444$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of M_{u2+}

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$$u = 1.1029765E-005$$

$$M_u = 9.1356E+007$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$c_o (5A.5, TBDY) = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} \cdot \text{Max}(c_u, c_c) = 0.00650344$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.00650344$$

$$w_e (5.4c) = 0.00563792$$

$$\text{ase ((5.4d), TBDY) = } (a_{se1} \cdot A_{ext} + a_{se2} \cdot A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

bi2_1 = 975400.00
ase2 = Max(ase1,ase2) = 0.14776895
bo_2 = 192.00
ho_2 = 492.00
bi2_2 = 557856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.25907

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.25221
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.25907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 268000.00
s1 = 150.00
s2 = 300.00
fywe1 = 694.4444
fywe2 = 694.4444
fce = 33.00

From ((5.A.5), TBDY), TBDY: cc = 0.00232446
c = confinement factor = 1.03245

y1 = 0.00097781
sh1 = 0.003129
ft1 = 325.9374
fy1 = 271.6145
su1 = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.17502824

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/d)^ 2/3), from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 271.6145

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.00097781
sh2 = 0.003129
ft2 = 325.9374
fy2 = 271.6145
su2 = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.17502824

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 = 271.6145

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

$y_v = 0.00097781$
 $sh_v = 0.003129$
 $ft_v = 325.9374$
 $fy_v = 271.6145$
 $su_v = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lo_{min} = lb/ld = 0.17502824$
 $su_v = 0.4 * esuv_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fs_v = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fs_v = fsv/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs_{jacket} * Asl_{mid,jacket} + fs_{mid} * Asl_{mid,core}) / Asl_{mid} = 271.6145$
 with $Esv = (Es_{jacket} * Asl_{mid,jacket} + Es_{mid} * Asl_{mid,core}) / Asl_{mid} = 200000.00$
 $1 = Asl_{ten} / (b * d) * (fs_1 / fc) = 0.03135046$
 $2 = Asl_{com} / (b * d) * (fs_2 / fc) = 0.03135046$
 $v = Asl_{mid} / (b * d) * (fsv / fc) = 0.01913459$

and confined core properties:

$b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 34.07072$
 $cc (5A.5, TBDY) = 0.00232446$
 $c = \text{confinement factor} = 1.03245$
 $1 = Asl_{ten} / (b * d) * (fs_1 / fc) = 0.0375932$
 $2 = Asl_{com} / (b * d) * (fs_2 / fc) = 0.0375932$
 $v = Asl_{mid} / (b * d) * (fsv / fc) = 0.02294481$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

$su (4.9) = 0.20535904$

$Mu = MRc (4.14) = 9.1356E+007$

$u = su (4.1) = 1.1029765E-005$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.17502824$

$lb = 300.00$

$ld = 1714.009$

Calculation of lb_{min} according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

ld_{min} from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$= 1$

$db = 15.23077$

Mean strength value of all re-bars: $fy = 694.4444$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$Ktr = 2.64216$

$n = 13.00$

Calculation of Mu_2 -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$u = 1.1029765E-005$

$Mu = 9.1356E+007$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$c_o (5A.5, TBDY) = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00650344$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.00650344$$

$$w_e (5.4c) = 0.00563792$$

$$a_{se} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25907$$

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.25221$$

$$p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.25907$$

$$p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$p_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.4444$$

$$f_{ywe2} = 694.4444$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } c_c = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$y_1 = 0.00097781$$

$$sh_1 = 0.003129$$

$$ft_1 = 325.9374$$

$$fy_1 = 271.6145$$

$$su_1 = 0.003129$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$l_o / l_{ou, \min} = l_b / d = 0.17502824$$

$$su_1 = 0.4 * e_{su1_nominal} ((5.5), TBDY) = 0.032$$

$$\text{From table 5A.1, TBDY: } e_{su1_nominal} = 0.08,$$

For calculation of $e_{su1_nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered characteristic value $f_{sy1} = f_{s1} / 1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b / d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } f_{s1} = (f_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + f_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 271.6145$$

$$\text{with } E_{s1} = (E_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + E_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 200000.00$$

y2 = 0.00097781
sh2 = 0.003129
ft2 = 325.9374
fy2 = 271.6145
su2 = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.17502824

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 = 271.6145

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.00097781
shv = 0.003129

ftv = 325.9374

fyv = 271.6145

suv = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 0.17502824

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY

For calculation of esuv_nominal and yv, shv,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 = 271.6145

with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.03135046

2 = Asl,com/(b*d)*(fs2/fc) = 0.03135046

v = Asl,mid/(b*d)*(fsv/fc) = 0.01913459

and confined core properties:

b = 610.00

d = 327.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07072

cc (5A.5, TBDY) = 0.00232446

c = confinement factor = 1.03245

1 = Asl,ten/(b*d)*(fs1/fc) = 0.0375932

2 = Asl,com/(b*d)*(fs2/fc) = 0.0375932

v = Asl,mid/(b*d)*(fsv/fc) = 0.02294481

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

v < vs,y2 - LHS eq.(4.5) is satisfied

--->

su (4.9) = 0.20535904

Mu = MRc (4.14) = 9.1356E+007

u = su (4.1) = 1.1029765E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.17502824

lb = 300.00

ld = 1714.009

Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

db = 15.23077

Mean strength value of all re-bars: fy = 694.4444

t = 1.16154

s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.64216
n = 13.00

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 383229.931$

Calculation of Shear Strength at edge 1, $V_{r1} = 383229.931$
 $V_{r1} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 197061.477$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot \text{Area}_{jacket} + f'_{c_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 33.00$, but $f'_c^{0.5} \leq 8.3$
MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 670.00$
 $d = 320.00$
 $V_u \cdot d / \mu < 1 = 0.00$
 $\mu = 2.6257021E-011$
 $V_u = 2.6375953E-014$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 186168.454$
 $V_{s1} = 186168.454$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 555.5556$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 0.00$ is calculated for jacket, with:
 $d_2 = 160.00$
 $A_v = 100530.965$
 $f_y = 555.5556$
 $s = 300.00$
 V_{s2} is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)
 V_f ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f \leq 818179.336$

Calculation of Shear Strength at edge 2, $V_{r2} = 383229.931$
 $V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 197061.477$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot \text{Area}_{jacket} + f'_{c_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 33.00$, but $f'_c^{0.5} \leq 8.3$
MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 670.00$
 $d = 320.00$
 $V_u \cdot d / \mu < 1 = 0.00$
 $\mu = 5.2870952E-011$
 $V_u = 2.6375953E-014$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 186168.454$
 $V_{s1} = 186168.454$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 555.5556$
 $s = 150.00$

Vs1 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

Vs2 = 0.00 is calculated for jacket, with:

d = 160.00

Av = 100530.965

fy = 555.5556

s = 300.00

Vs2 is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)

Vf ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: Vs + Vf <= 818179.336

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor, = 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 = 555.5556

Concrete Elasticity, Ec = 26999.444

Steel Elasticity, Es = 200000.00

Existing Column

New material of Secondary Member: Concrete Strength, fc = fcm = 33.00

New material of Secondary Member: Steel Strength, fs = fsm = 555.5556

Concrete Elasticity, Ec = 26999.444

Steel Elasticity, Es = 200000.00

External Height, H = 670.00

External Width, W = 400.00

Internal Height, H = 500.00

Internal Width, W = 200.00

Cover Thickness, c = 25.00

Element Length, L = 3000.00

Secondary Member

Smooth Bars

Ductile Steel

With Detailing for Earthquake Resistance (including stirrups closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length lb = 300.00

No FRP Wrapping

Stepwise Properties

Bending Moment, M = 2.3048016E-010

Shear Force, V2 = 1.2862848E-013

Shear Force, V3 = -919.1918

Axial Force, F = -4784.664

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: Aslt = 709.9999

-Compression: Aslc = 1668.186

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: Asl,ten = 911.0619

-Compression: Asl,com = 911.0619

-Middle: Asl,mid = 556.0619

Longitudinal External Reinforcement Area Distribution (in 3 divisions)

-Tension: Asl,ten,jacket = 603.1858

-Compression: $Asl,com,jacket = 603.1858$

-Middle: $Asl,mid,jacket = 402.1239$

Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)

-Tension: $Asl,ten,core = 307.8761$

-Compression: $Asl,com,core = 307.8761$

-Middle: $Asl,mid,core = 153.938$

Mean Diameter of Tension Reinforcement, $DbL = 15.20$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u,R = 1.0^*$ $u = 0.02156999$

$u = y + p = 0.02156999$

- Calculation of y -

$y = (My*Ls/3)/Eleff = 0.00156999$ ((4.29),Biskinis Phd))

$My = 9.0882E+007$

$Ls = M/V$ (with $Ls > 0.1*L$ and $Ls < 2*L$) = 1500.00

From table 10.5, ASCE 41_17: $Eleff = 0.3*Ec*lg = 2.8943E+013$

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$

$y_{ten} = 4.5534001E-006$

with ((10.1), ASCE 41-17) $fy = \text{Min}(fy, 1.25*fy*(lb/d)^{2/3}) = 252.1446$

$d = 357.00$

$y = 0.22443969$

$A = 0.010022$

$B = 0.00564945$

with $pt = 0.00380895$

$pc = 0.00380895$

$pv = 0.00232477$

$N = 4784.664$

$b = 670.00$

" = 0.12044818

$y_{comp} = 2.7615117E-005$

with $fc = 33.00$

$Ec = 26999.444$

$y = 0.22316008$

$A = 0.0098972$

$B = 0.00557012$

with $Es = 200000.00$

Calculation of ratio lb/d

Lap Length: $ld/d,min = 0.2187853$

$lb = 300.00$

$ld = 1371.207$

Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)

= 1

$db = 15.23077$

Mean strength value of all re-bars: $fy = 555.5556$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$Ktr = 2.64216$

$n = 13.00$

- Calculation of ρ -

From table 10-7: $\rho = 0.02$

with:

- Condition iv occurred

Beam controlled by inadequate embedment into beam-column joint:
($l_b/d < 1$ and With Lapping in the Vicinity of the End Regions

- Condition i occurred

Beam controlled by flexure: $V_p/V_o \leq 1$

shear control ratio $V_p/V_o = 0.15892241$

- Transverse Reinforcement: NC

- Stirrup Spacing $> d/3$

- Low ductility demand, $\lambda / y < 2$ (table 10-6, ASCE 41-17)

$$= 6.7785385E-022$$

- Stirrup Spacing $\leq d/2$

$$d = d_{\text{external}} = 357.00$$

$$s = s_{\text{external}} = 150.00$$

- Strength provided by hoops $V_s < 3/4 \cdot \text{design Shear}$

$$V_s = 215955.406, \text{ already given in calculation of shear control ratio}$$

$$\text{design Shear} = 1.2862848E-013$$

- (ρ) / $\rho_{\text{bal}} = -0.23508642$

$$= A_{s1}/(b_w \cdot d) = 0.00296835$$

$$\text{Tension Reinf Area: } A_{s1} = 709.9999$$

$$\rho' = A_{s2}/(b_w \cdot d) = 0.00697431$$

$$\text{Compression Reinf Area: } A_{s2} = 1668.186$$

$$\text{From (B-1), ACI 318-11: } \rho_{\text{bal}} = 0.01704038$$

$$f_c = (f_{c,\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f_{c,\text{core}} \cdot \text{Area}_{\text{core}}) / \text{section_area} = 33.00$$

$$f_y = f_{y,\text{jacket_bars}} = 555.5556$$

$$\text{From 10.2.7.3, ACI 318-11: } \lambda = 0.65$$

$$\text{From fig R10.3.3, ACI 318-11 (Ence 454, too): } 87000 / (87000 + f_y) = c_b/d_t = 0.003 / (0.003 + y) = 0.51923077$$

$$y = 0.00277778$$

- $V / (b_w \cdot d \cdot f_c^{0.5}) = 1.1273542E-018$, NOTE: units in lb & in

$$b_w = 670.00$$

End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (a)

Calculation No. 13

beam B1, Floor 1

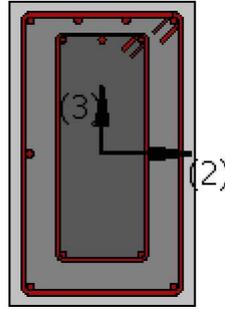
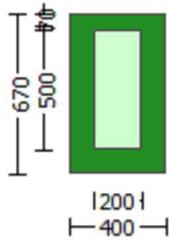
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: End

Local Axis: (2)



Start Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (b)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

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

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, $E_s = 200000.00$

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

With Detailing for Earthquake Resistance (including stirrups closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = l_b = 300.00$

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 2.3048016E-010$

Shear Force, $V_a = 1.2862848E-013$

EDGE -B-

Bending Moment, $M_b = 1.5504614E-010$

Shear Force, $V_b = -1.2862848E-013$

BOTH EDGES

Axial Force, $F = -4784.664$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{sl} = 709.9999$

-Compression: $A_{sc} = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{sl,ten} = 911.0619$

-Compression: $A_{sl,com} = 911.0619$

-Middle: $As_{l,mid} = 556.0619$

Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 15.20$

New component: From table 7-7, ASCE 41_17: Final Shear Capacity $VR = 1.0 \cdot V_n = 339071.608$
 V_n ((22.5.1.1), ACI 318-14) = 339071.608

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 171520.00$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c,jacket} \cdot Area_{jacket} + f'_{c,core} \cdot Area_{core}) / Area_{section} = 25.00$, but $f'_c^{0.5} \leq 8.3$
MPa (22.5.3.1, ACI 318-14)

$\rho_w = As / (b_w \cdot d) = 0.00331157$

As (tension reinf.) = 709.9999

$b_w = 670.00$

$d = 320.00$

$V_u \cdot d / M_u < 1 = 0.00$

$M_u = 1.5504614E-010$

$V_u = 1.2862848E-013$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 167551.608$

$V_{s1} = 167551.608$ is calculated for jacket, with:

$d = 320.00$

$A_v = 157079.633$

$f_y = 500.00$

$s = 150.00$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 0.00$ is calculated for core, with:

$d = 160.00$

$A_v = 100530.965$

$f_y = 500.00$

$s = 300.00$

V_{s2} is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)

V_f ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: $V_s + V_f \leq 712133.705$

End Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (b)

Calculation No. 14

beam B1, Floor 1

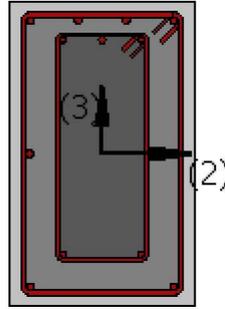
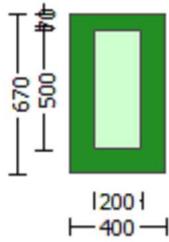
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (θ_u)

Edge: End

Local Axis: (2)



Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 3
 (Bending local axis: 2)
 Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 1.00$
 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, $f_s = f_{sm} = 555.5556$
 Concrete Elasticity, $E_c = 26999.444$
 Steel Elasticity, $E_s = 200000.00$

Existing Column
 New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
 New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.5556$
 Concrete Elasticity, $E_c = 26999.444$
 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, $f_s = 1.25 \cdot f_{sm} = 694.4444$
 Existing Column
 New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 694.4444$
 #####

External Height, $H = 670.00$
 External Width, $W = 400.00$
 Internal Height, $H = 500.00$
 Internal Width, $W = 200.00$
 Cover Thickness, $c = 25.00$
 Mean Confinement Factor overall section = 1.03245
 Element Length, $L = 3000.00$
 Secondary Member
 Smooth Bars
 Ductile Steel
 With Detailing for Earthquake Resistance (including stirrups closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Lap Length $l_o = 300.00$
 No FRP Wrapping

Stepwise Properties

At local axis: 3
 EDGE -A-
 Shear Force, $V_a = 9840.633$
 EDGE -B-
 Shear Force, $V_b = 9840.633$
 BOTH EDGES

Axial Force, $F = -2237.255$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $As_t = 709.9999$
-Compression: $As_c = 1668.186$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $As_{t,ten} = 709.9999$
-Compression: $As_{c,com} = 1266.062$
-Middle: $As_{c,mid} = 402.1239$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.2867466$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 160061.187$
with

$M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 2.2533E+008$
 $Mu_{1+} = 1.1683E+008$, 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
 $Mu_{1-} = 2.2533E+008$, 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
 $M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 2.2533E+008$
 $Mu_{2+} = 1.1683E+008$, 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
 $Mu_{2-} = 2.2533E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination
and
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$
with
 $V_1 = 9840.633$, is the shear force acting at edge 1 for the static loading combination
 $V_2 = 9840.633$, is the shear force acting at edge 2 for the static loading combination

Calculation of Mu_{1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 6.1426221E-006$
 $M_u = 1.1683E+008$

with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.00027032$
 $N = 2237.255$
 $f_c = 33.00$
 ϕ_c (5A.5, TBDY) = 0.002
Final value of ϕ_c : $\phi_c^* = \text{shear_factor} \cdot \text{Max}(\phi_c, \phi_c) = 0.00650344$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $\phi_c = 0.00650344$
 w_e (5.4c) = 0.00563792
 ase ((5.4d), TBDY) = $(ase_1 \cdot A_{ext} + ase_2 \cdot A_{int})/A_{sec} = 0.14776895$
 $ase_1 = 0.14776895$
 $bo_1 = 340.00$
 $ho_1 = 610.00$
 $bi_2_1 = 975400.00$
 $ase_2 = \text{Max}(ase_1, ase_2) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi_2_2 = 557856.00$
 $psh_{min} \cdot F_{ywe} = \text{Min}(psh_x \cdot F_{ywe}, psh_y \cdot F_{ywe}) = 1.25907$

 $psh_x \cdot F_{ywe} = psh_1 \cdot F_{ywe1} + ps_2 \cdot F_{ywe2} = 2.25221$
 ps_1 (external) = $(A_{sh1} \cdot h_1/s_1)/A_{sec} = 0.00261799$
 $A_{sh1} = Astir_1 \cdot ns_1 = 157.0796$

No stirups, ns₁ = 2.00
h₁ = 670.00
ps₂ (internal) = (Ash₂*h₂/s₂)/Asec = 0.00062519
Ash₂ = Astir₂*ns₂ = 100.531
No stirups, ns₂ = 2.00
h₂ = 500.00

psh_y*Fywe = psh₁*Fywe₁+ps₂*Fywe₂ = 1.25907
ps₁ (external) = (Ash₁*h₁/s₁)/Asec = 0.00156298
Ash₁ = Astir₁*ns₁ = 157.0796
No stirups, ns₁ = 2.00
h₁ = 400.00
ps₂ (internal) = (Ash₂*h₂/s₂)/Asec = 0.00025008
Ash₂ = Astir₂*ns₂ = 100.531
No stirups, ns₂ = 2.00
h₂ = 200.00

Asec = 268000.00
s₁ = 150.00
s₂ = 300.00
fywe₁ = 694.4444
fywe₂ = 694.4444
fce = 33.00

From ((5.A.5), TBDY), TBDY: cc = 0.00232446
c = confinement factor = 1.03245

y₁ = 0.00097781
sh₁ = 0.003129
ft₁ = 325.9374
fy₁ = 271.6145
su₁ = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.17502824

su₁ = 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 y₁, sh₁,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/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} = 271.6145

with Es₁ = (Es_{jacket}*Asl_{ten,jacket} + Es_{core}*Asl_{ten,core})/Asl_{ten} = 200000.00

y₂ = 0.00097781
sh₂ = 0.003129
ft₂ = 325.9374
fy₂ = 271.6145
su₂ = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with 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} = 0.17502824

su₂ = 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 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/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} = 271.6145

with Es₂ = (Es_{jacket}*Asl_{com,jacket} + Es_{core}*Asl_{com,core})/Asl_{com} = 200000.00

y_v = 0.00097781
sh_v = 0.003129
ft_v = 325.9374
fy_v = 271.6145
suv = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.17502824

suv = 0.4*esuv_{nominal} ((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 $esuv_nominal$ 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 $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 271.6145$
 with $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.02330074$
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.04154956$
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.01319688$

and confined core properties:

$b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 f_{cc} (5A.2, TBDY) = 34.07072
 cc (5A.5, TBDY) = 0.00232446
 $c = \text{confinement factor} = 1.03245$
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.02879016$
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.0513382$
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.01630593$

Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

---->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

---->
 su (4.9) = 0.18757351
 $Mu = MRc$ (4.14) = 1.1683E+008
 $u = su$ (4.1) = 6.1426221E-006

 Calculation of ratio lb/ld

 Lap Length: $lb/ld = 0.17502824$

$lb = 300.00$
 $ld = 1714.009$

Calculation of lb_{min} according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 ld_{min} from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$= 1$
 $db = 15.23077$
 Mean strength value of all re-bars: $fy = 694.4444$
 $t = 1.16154$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.64216$
 $n = 13.00$

 Calculation of Mu_1 -

 Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$u = 6.3198187E-006$
 $Mu = 2.2533E+008$

 with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.00027032$
 $N = 2237.255$
 $f_c = 33.00$
 co (5A.5, TBDY) = 0.002

Final value of cu : $cu^* = \text{shear_factor} \cdot \text{Max}(cu, cc) = 0.00650344$
 The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $c_u = 0.00650344$
we (5.4c) = 0.00563792
ase ((5.4d), TBDY) = $(ase1 \cdot A_{ext} + ase2 \cdot A_{int}) / A_{sec} = 0.14776895$
ase1 = 0.14776895
bo_1 = 340.00
ho_1 = 610.00
bi2_1 = 975400.00
ase2 = Max(ase1,ase2) = 0.14776895
bo_2 = 192.00
ho_2 = 492.00
bi2_2 = 557856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.25907

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.25221
ps1 (external) = $(Ash1 \cdot h1 / s1) / A_{sec} = 0.00261799$
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = $(Ash2 \cdot h2 / s2) / A_{sec} = 0.00062519$
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.25907
ps1 (external) = $(Ash1 \cdot h1 / s1) / A_{sec} = 0.00156298$
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = $(Ash2 \cdot h2 / s2) / A_{sec} = 0.00025008$
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 268000.00
s1 = 150.00
s2 = 300.00
fywe1 = 694.4444
fywe2 = 694.4444
fce = 33.00

From ((5.A5), TBDY), TBDY: $c_c = 0.00232446$
c = confinement factor = 1.03245

y1 = 0.00097781
sh1 = 0.003129
ft1 = 325.9374
fy1 = 271.6145
su1 = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 0.17502824

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 $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs1 = (fs_{jacket} \cdot A_{s,ten,jacket} + fs_{core} \cdot A_{s,ten,core}) / A_{s,ten} = 271.6145$

with $Es1 = (Es_{jacket} \cdot A_{s,ten,jacket} + Es_{core} \cdot A_{s,ten,core}) / A_{s,ten} = 200000.00$

y2 = 0.00097781
sh2 = 0.003129
ft2 = 325.9374
fy2 = 271.6145
su2 = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.17502824

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 $fs2 = (fs_jacket \cdot Asl,com,jacket + fs_core \cdot Asl,com,core) / Asl,com = 271.6145$

with $Es2 = (Es_jacket \cdot Asl,com,jacket + Es_core \cdot Asl,com,core) / Asl,com = 200000.00$

$yv = 0.000977781$

$shv = 0.003129$

$ftv = 325.9374$

$fyv = 271.6145$

$suv = 0.003129$

using (30) in Biskinis/Fardis (2013) multiplied with $shear_factor$

and also multiplied by the $shear_factor$ according to 15.7.1.4, with

$Shear_factor = 1.00$

$lo/lo, min = lb/ld = 0.17502824$

$suv = 0.4 \cdot esuv_nominal$ ((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 $fsv = (fs_jacket \cdot Asl,mid,jacket + fs_mid \cdot Asl,mid,core) / Asl,mid = 271.6145$

with $Es_v = (Es_jacket \cdot Asl,mid,jacket + Es_mid \cdot Asl,mid,core) / Asl,mid = 200000.00$

$1 = Asl,ten / (b \cdot d) \cdot (fs1 / fc) = 0.04154956$

$2 = Asl,com / (b \cdot d) \cdot (fs2 / fc) = 0.02330074$

$v = Asl,mid / (b \cdot d) \cdot (fsv / fc) = 0.01319688$

and confined core properties:

$b = 340.00$

$d = 597.00$

$d' = 13.00$

fcc (5A.2, TBDY) = 34.07072

cc (5A.5, TBDY) = 0.00232446

$c =$ confinement factor = 1.03245

$1 = Asl,ten / (b \cdot d) \cdot (fs1 / fc) = 0.0513382$

$2 = Asl,com / (b \cdot d) \cdot (fs2 / fc) = 0.02879016$

$v = Asl,mid / (b \cdot d) \cdot (fsv / fc) = 0.01630593$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < vs,y2$ - LHS eq.(4.5) is satisfied

--->

su (4.9) = 0.21035251

$Mu = MRc$ (4.14) = 2.2533E+008

$u = su$ (4.1) = 6.3198187E-006

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.17502824$

$lb = 300.00$

$ld = 1714.009$

Calculation of lb, min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

ld, min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

$db = 15.23077$

Mean strength value of all re-bars: $fy = 694.4444$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$Ktr = 2.64216$

$n = 13.00$

Calculation of $Mu2+$

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$$u = 6.1426221E-006$$

$$\mu = 1.1683E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$c_o(5A.5, \text{TBDY}) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.00650344$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.00650344$$

$$\phi_{we} \text{ (5.4c)} = 0.00563792$$

$$\text{ase ((5.4d), TBDY)} = (\text{ase1} * A_{ext} + \text{ase2} * A_{int}) / A_{sec} = 0.14776895$$

$$\text{ase1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$\text{ase2} = \text{Max}(\text{ase1}, \text{ase2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$\text{psh}_{\min} * F_{ywe} = \text{Min}(\text{psh}_{x} * F_{ywe}, \text{psh}_{y} * F_{ywe}) = 1.25907$$

$$\text{psh}_{x} * F_{ywe} = \text{psh1} * F_{ywe1} + \text{ps2} * F_{ywe2} = 2.25221$$

$$\text{ps1 (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$\text{ps2 (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$\text{psh}_{y} * F_{ywe} = \text{psh1} * F_{ywe1} + \text{ps2} * F_{ywe2} = 1.25907$$

$$\text{ps1 (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$\text{ps2 (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.4444$$

$$f_{ywe2} = 694.4444$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A.5), TBDY), TBDY: } \phi_{cc} = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$y_1 = 0.00097781$$

$$sh_1 = 0.003129$$

$$ft_1 = 325.9374$$

$$fy_1 = 271.6145$$

$$su_1 = 0.003129$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$l_o / l_{ou, \min} = l_b / d = 0.17502824$$

$$su_1 = 0.4 * esu_{1_nominal} \text{ ((5.5), TBDY)} = 0.032$$

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 $fs1 = (fs_jacket \cdot Asl,ten,jacket + fs_core \cdot Asl,ten,core) / Asl,ten = 271.6145$

with $Es1 = (Es_jacket \cdot Asl,ten,jacket + Es_core \cdot Asl,ten,core) / Asl,ten = 200000.00$

$$y2 = 0.00097781$$

$$sh2 = 0.003129$$

$$ft2 = 325.9374$$

$$fy2 = 271.6145$$

$$su2 = 0.003129$$

using (30) in Biskinis/Fardis (2013) multiplied with $shear_factor$

and also multiplied by the $shear_factor$ according to 15.7.1.4, with

$Shear_factor = 1.00$

$$lo/lou,min = lb/lb,min = 0.17502824$$

$$su2 = 0.4 \cdot esu2_nominal \text{ ((5.5), TBDY)} = 0.032$$

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 $fs2 = (fs_jacket \cdot Asl,com,jacket + fs_core \cdot Asl,com,core) / Asl,com = 271.6145$

with $Es2 = (Es_jacket \cdot Asl,com,jacket + Es_core \cdot Asl,com,core) / Asl,com = 200000.00$

$$yv = 0.00097781$$

$$shv = 0.003129$$

$$ftv = 325.9374$$

$$fyv = 271.6145$$

$$suv = 0.003129$$

using (30) in Biskinis/Fardis (2013) multiplied with $shear_factor$

and also multiplied by the $shear_factor$ according to 15.7.1.4, with

$Shear_factor = 1.00$

$$lo/lou,min = lb/ld = 0.17502824$$

$$suv = 0.4 \cdot esuv_nominal \text{ ((5.5), TBDY)} = 0.032$$

From table 5A.1, TBDY: $esuv_nominal = 0.08$,

considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY

For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered

characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fsv = (fs_jacket \cdot Asl,mid,jacket + fs_mid \cdot Asl,mid,core) / Asl,mid = 271.6145$

with $Es_v = (Es_jacket \cdot Asl,mid,jacket + Es_mid \cdot Asl,mid,core) / Asl,mid = 200000.00$

$$1 = Asl,ten / (b \cdot d) \cdot (fs1 / fc) = 0.02330074$$

$$2 = Asl,com / (b \cdot d) \cdot (fs2 / fc) = 0.04154956$$

$$v = Asl,mid / (b \cdot d) \cdot (fsv / fc) = 0.01319688$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc \text{ (5A.2, TBDY)} = 34.07072$$

$$cc \text{ (5A.5, TBDY)} = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$1 = Asl,ten / (b \cdot d) \cdot (fs1 / fc) = 0.02879016$$

$$2 = Asl,com / (b \cdot d) \cdot (fs2 / fc) = 0.0513382$$

$$v = Asl,mid / (b \cdot d) \cdot (fsv / fc) = 0.01630593$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < vs,y2$ - LHS eq.(4.5) is satisfied

--->

$$su \text{ (4.9)} = 0.18757351$$

$$Mu = MRc \text{ (4.14)} = 1.1683E+008$$

$$u = su \text{ (4.1)} = 6.1426221E-006$$

Calculation of ratio lb/ld

$$\text{Lap Length: } lb/ld = 0.17502824$$

$$lb = 300.00$$

$$ld = 1714.009$$

Calculation of $I_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $I_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1
 $db = 15.23077$
Mean strength value of all re-bars: $f_y = 694.4444$
 $t = 1.16154$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.64216$
 $n = 13.00$

Calculation of μ_2 -

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:
 $\mu = 6.3198187E-006$
 $\mu_u = 2.2533E+008$

with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.00027032$
 $N = 2237.255$
 $f_c = 33.00$
 α (5A.5, TBDY) = 0.002
Final value of α : $\alpha^* = \text{shear_factor} * \text{Max}(\alpha, \alpha_c) = 0.00650344$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $\alpha_c = 0.00650344$
 w_e (5.4c) = 0.00563792
 α_{se} ((5.4d), TBDY) = $(\alpha_{se1} * A_{ext} + \alpha_{se2} * A_{int}) / A_{sec} = 0.14776895$
 $\alpha_{se1} = 0.14776895$
 $b_{o,1} = 340.00$
 $h_{o,1} = 610.00$
 $b_{i2,1} = 975400.00$
 $\alpha_{se2} = \text{Max}(\alpha_{se1}, \alpha_{se2}) = 0.14776895$
 $b_{o,2} = 192.00$
 $h_{o,2} = 492.00$
 $b_{i2,2} = 557856.00$
 $p_{sh,min} * F_{ywe} = \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.25907$

 $p_{sh,x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.25221$
 p_{s1} (external) = $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir,1} * n_{s,1} = 157.0796$
No stirups, $n_{s,1} = 2.00$
 $h_1 = 670.00$
 p_{s2} (internal) = $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$
 $A_{sh2} = A_{stir,2} * n_{s,2} = 100.531$
No stirups, $n_{s,2} = 2.00$
 $h_2 = 500.00$

 $p_{sh,y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.25907$
 p_{s1} (external) = $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$
 $A_{sh1} = A_{stir,1} * n_{s,1} = 157.0796$
No stirups, $n_{s,1} = 2.00$
 $h_1 = 400.00$
 p_{s2} (internal) = $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$
 $A_{sh2} = A_{stir,2} * n_{s,2} = 100.531$
No stirups, $n_{s,2} = 2.00$
 $h_2 = 200.00$

 $A_{sec} = 268000.00$
 $s_1 = 150.00$

$s_2 = 300.00$
 $fy_{we1} = 694.4444$
 $fy_{we2} = 694.4444$
 $f_{ce} = 33.00$
 From ((5.A5), TBDY), TBDY: $cc = 0.00232446$
 $c = \text{confinement factor} = 1.03245$
 $y_1 = 0.00097781$
 $sh_1 = 0.003129$
 $ft_1 = 325.9374$
 $fy_1 = 271.6145$
 $su_1 = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou, \min = lb/d = 0.17502824$
 $su_1 = 0.4 * esu_1 \text{ nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_1 \text{ nominal} = 0.08$,
 For calculation of $esu_1 \text{ nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered
 characteristic value $fsy_1 = fs_1/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_1 = (fs_{jacket} * Asl, \text{ten, jacket} + fs_{core} * Asl, \text{ten, core}) / Asl, \text{ten} = 271.6145$
 with $Es_1 = (Es_{jacket} * Asl, \text{ten, jacket} + Es_{core} * Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$
 $y_2 = 0.00097781$
 $sh_2 = 0.003129$
 $ft_2 = 325.9374$
 $fy_2 = 271.6145$
 $su_2 = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou, \min = lb/lb, \min = 0.17502824$
 $su_2 = 0.4 * esu_2 \text{ nominal} ((5.5), TBDY) = 0.032$
 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 $\text{Min}(1, 1.25 * (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = (fs_{jacket} * Asl, \text{com, jacket} + fs_{core} * Asl, \text{com, core}) / Asl, \text{com} = 271.6145$
 with $Es_2 = (Es_{jacket} * Asl, \text{com, jacket} + Es_{core} * Asl, \text{com, core}) / Asl, \text{com} = 200000.00$
 $y_v = 0.00097781$
 $sh_v = 0.003129$
 $ft_v = 325.9374$
 $fy_v = 271.6145$
 $suv = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou, \min = lb/d = 0.17502824$
 $suv = 0.4 * esuv \text{ nominal} ((5.5), TBDY) = 0.032$
 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 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 $\text{Min}(1, 1.25 * (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs_{jacket} * Asl, \text{mid, jacket} + fs_{mid} * Asl, \text{mid, core}) / Asl, \text{mid} = 271.6145$
 with $Es_v = (Es_{jacket} * Asl, \text{mid, jacket} + Es_{mid} * Asl, \text{mid, core}) / Asl, \text{mid} = 200000.00$
 $1 = Asl, \text{ten} / (b * d) * (fs_1 / f_c) = 0.04154956$
 $2 = Asl, \text{com} / (b * d) * (fs_2 / f_c) = 0.02330074$
 $v = Asl, \text{mid} / (b * d) * (fsv / f_c) = 0.01319688$
 and confined core properties:
 $b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 34.07072$
 $cc (5A.5, TBDY) = 0.00232446$
 $c = \text{confinement factor} = 1.03245$
 $1 = Asl, \text{ten} / (b * d) * (fs_1 / f_c) = 0.0513382$
 $2 = Asl, \text{com} / (b * d) * (fs_2 / f_c) = 0.02879016$

$$v = A_{sl, mid} / (b * d) * (f_{sv} / f_c) = 0.01630593$$

Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)

$v < v_{s, y2}$ - LHS eq.(4.5) is satisfied

$$s_u(4.9) = 0.21035251$$

$$\mu = M_{Rc}(4.14) = 2.2533E+008$$

$$u = s_u(4.1) = 6.3198187E-006$$

Calculation of ratio l_b / l_d

Lap Length: $l_b / l_d = 0.17502824$

$$l_b = 300.00$$

$$l_d = 1714.009$$

Calculation of l_b, min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

l_d, min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$d_b = 15.23077$$

$$\text{Mean strength value of all re-bars: } f_y = 694.4444$$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 558197.326$

Calculation of Shear Strength at edge 1, $V_{r1} = 558197.326$

$$V_{r1} = V_n \text{ ((22.5.1.1), ACI 318-14)}$$

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f * V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 209131.476$

= 1 (normal-weight concrete)

Mean concrete strength: $f'_c = (f'_{c, jacket} * \text{Area}_{jacket} + f'_{c, core} * \text{Area}_{core}) / \text{Area}_{section} = 33.00$, but $f'_c^{0.5} \leq 8.3$
MPa (22.5.3.1, ACI 318-14)

$$p_w = A_s / (b_w * d) = 0.00331157$$

$$A_s \text{ (tension reinf.)} = 709.9999$$

$$b_w = 400.00$$

$$d = 536.00$$

$$V_u * d / \mu < 1 = 1.00$$

$$\mu = 1.0197E+006$$

$$V_u = 9840.633$$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 349065.85$

$V_{s1} = 311832.16$ is calculated for jacket, with:

$$d = 536.00$$

$$A_v = 157079.633$$

$$f_y = 555.5556$$

$$s = 150.00$$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17, 10.3.4)

$V_{s2} = 37233.691$ is calculated for jacket, with:

$$d_2 = 400.00$$

$$A_v = 100530.965$$

$$f_y = 555.5556$$

$$s = 300.00$$

V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17, 10.3.4)

$$2(1-s/d) = 0.50$$

$$V_f \text{ ((11-3)-(11.4), ACI 440)} = 0.00$$

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 818179.336$$

Calculation of Shear Strength at edge 2, Vr2 = 558197.326
Vr2 = Vn ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: Vc = 209131.476
= 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc'^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
pw = As/(bw*d) = 0.00331157
As (tension reinf.) = 709.9999
bw = 400.00
d = 536.00
Vu*d/Mu < 1 = 1.00
Mu = 1.0197E+006
Vu = 9840.633
From (11.5.4.8), ACI 318-14: Vs1 + Vs2 = 349065.85
Vs1 = 311832.16 is calculated for jacket, with:
d = 536.00
Av = 157079.633
fy = 555.5556
s = 150.00
Vs1 has been multiplied by 1 (s<d/2, according to ASCE 41-17,10.3.4)
Vs2 = 37233.691 is calculated for jacket, with:
d = 400.00
Av = 100530.965
fy = 555.5556
s = 300.00
Vs2 has been multiplied by 2(1-s/d) (s>d/2, according to ASCE 41-17,10.3.4)
2(1-s/d) = 0.50
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 818179.336

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjars

Constant Properties

Knowledge Factor, = 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 = 555.5556
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.5556
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00

Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.4444
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.4444

#####

External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03245
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length l_o = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, V_a = -2.6375953E-014
EDGE -B-
Shear Force, V_b = 2.6375953E-014
BOTH EDGES
Axial Force, F = -2237.255
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{sl,t}$ = 709.9999
-Compression: $A_{sl,c}$ = 1668.186
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{sl,ten}$ = 911.0619
-Compression: $A_{sl,com}$ = 911.0619
-Middle: $A_{sl,mid}$ = 556.0619

Calculation of Shear Capacity ratio , V_e/V_r = 0.15892241
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u * l_n / 2 = 60903.823$
with
 $M_{pr1} = \text{Max}(Mu_{1+} , Mu_{1-}) = 9.1356E+007$
 $Mu_{1+} = 9.1356E+007$, 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
 $Mu_{1-} = 9.1356E+007$, 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
 $M_{pr2} = \text{Max}(Mu_{2+} , Mu_{2-}) = 9.1356E+007$
 $Mu_{2+} = 9.1356E+007$, 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
 $Mu_{2-} = 9.1356E+007$, is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination
and
 $\pm w_u * l_n = (|V_1| + |V_2|)/2$
with
 $V_1 = -2.6375953E-014$, is the shear force acting at edge 1 for the the static loading combination
 $V_2 = 2.6375953E-014$, is the shear force acting at edge 2 for the the static loading combination

Calculation of Mu_{1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 1.1029765E-005$
 $Mu = 9.1356E+007$

with full section properties:

$b = 670.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.00028344$
 $N = 2237.255$
 $f_c = 33.00$
 $c_o (5A.5, TBDY) = 0.002$
 Final value of c_u : $c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00650344$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $c_u = 0.00650344$
 $w_e (5.4c) = 0.00563792$
 $a_{se} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$
 $a_{se1} = 0.14776895$
 $b_{o_1} = 340.00$
 $h_{o_1} = 610.00$
 $b_{i2_1} = 975400.00$
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$
 $b_{o_2} = 192.00$
 $h_{o_2} = 492.00$
 $b_{i2_2} = 557856.00$
 $p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25907$

$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.25221$
 $p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirups, $n_{s_1} = 2.00$
 $h_1 = 670.00$
 $p_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirups, $n_{s_2} = 2.00$
 $h_2 = 500.00$

$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.25907$
 $p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirups, $n_{s_1} = 2.00$
 $h_1 = 400.00$
 $p_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirups, $n_{s_2} = 2.00$
 $h_2 = 200.00$

$A_{sec} = 268000.00$
 $s_1 = 150.00$
 $s_2 = 300.00$
 $f_{ywe1} = 694.4444$
 $f_{ywe2} = 694.4444$
 $f_{ce} = 33.00$

From ((5.A5), TBDY), TBDY: $c_c = 0.00232446$
 $c = \text{confinement factor} = 1.03245$
 $y_1 = 0.00097781$
 $sh_1 = 0.003129$
 $ft_1 = 325.9374$
 $fy_1 = 271.6145$
 $su_1 = 0.003129$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $l_o / l_{ou, \min} = l_b / d = 0.17502824$
 $su_1 = 0.4 * e_{su1_nominal} ((5.5), TBDY) = 0.032$
 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 $f_{sy1} = f_{s1} / 1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b / d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{s1} = (f_{s, \text{jacket}} * A_{s1, \text{ten, jacket}} + f_{s, \text{core}} * A_{s1, \text{ten, core}}) / A_{s1, \text{ten}}$
 with $E_{s1} = (E_{s, \text{jacket}} * A_{s1, \text{ten, jacket}} + E_{s, \text{core}} * A_{s1, \text{ten, core}}) / A_{s1, \text{ten}} = 200000.00$
 $y_2 = 0.00097781$

$sh_2 = 0.003129$
 $ft_2 = 325.9374$
 $fy_2 = 271.6145$
 $su_2 = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/lb,min = 0.17502824$
 $su_2 = 0.4*esu_2,nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_2,nominal = 0.08$,
 For calculation of $esu_2,nominal$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 271.6145$
 with $Es_2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00$
 $yv = 0.00097781$
 $shv = 0.003129$
 $ftv = 325.9374$
 $fyv = 271.6145$
 $suv = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/ld = 0.17502824$
 $suv = 0.4*esuv,nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv,nominal = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv,nominal$ and yv, shv,ftv,fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 271.6145$
 with $Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00$
 $1 = Asl,ten/(b*d)*(fs_1/fc) = 0.03135046$
 $2 = Asl,com/(b*d)*(fs_2/fc) = 0.03135046$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.01913459$

and confined core properties:

$b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 34.07072$
 $cc (5A.5, TBDY) = 0.00232446$
 $c = \text{confinement factor} = 1.03245$
 $1 = Asl,ten/(b*d)*(fs_1/fc) = 0.0375932$
 $2 = Asl,com/(b*d)*(fs_2/fc) = 0.0375932$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.02294481$

Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

--->
 $v < vs,y_2$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.20535904$
 $Mu = MRc (4.14) = 9.1356E+007$
 $u = su (4.1) = 1.1029765E-005$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.17502824$
 $lb = 300.00$
 $ld = 1714.009$
 Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 15.23077$
 Mean strength value of all re-bars: $fy = 694.4444$
 $t = 1.16154$
 $s = 0.80$

e = 1.00
cb = 25.00
Ktr = 2.64216
n = 13.00

Calculation of Mu1-

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:

u = 1.1029765E-005
Mu = 9.1356E+007

with full section properties:

b = 670.00
d = 357.00
d' = 43.00
v = 0.00028344
N = 2237.255
fc = 33.00
co (5A.5, TBDY) = 0.002

Final value of c_u : $c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00650344$
The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $c_u = 0.00650344$

we (5.4c) = 0.00563792

ase ((5.4d), TBDY) = $(\text{ase1} * \text{Aext} + \text{ase2} * \text{Aint}) / \text{Asec} = 0.14776895$

ase1 = 0.14776895

bo_1 = 340.00

ho_1 = 610.00

bi2_1 = 975400.00

ase2 = $\text{Max}(\text{ase1}, \text{ase2}) = 0.14776895$

bo_2 = 192.00

ho_2 = 492.00

bi2_2 = 557856.00

$\text{psh}_{\text{min}} * \text{Fywe} = \text{Min}(\text{psh}_x * \text{Fywe}, \text{psh}_y * \text{Fywe}) = 1.25907$

 $\text{psh}_x * \text{Fywe} = \text{psh1} * \text{Fywe1} + \text{ps2} * \text{Fywe2} = 2.25221$

ps1 (external) = $(\text{Ash1} * \text{h1} / \text{s1}) / \text{Asec} = 0.00261799$

Ash1 = $\text{Astir}_1 * \text{ns}_1 = 157.0796$

No stirups, ns_1 = 2.00

h1 = 670.00

ps2 (internal) = $(\text{Ash2} * \text{h2} / \text{s2}) / \text{Asec} = 0.00062519$

Ash2 = $\text{Astir}_2 * \text{ns}_2 = 100.531$

No stirups, ns_2 = 2.00

h2 = 500.00

 $\text{psh}_y * \text{Fywe} = \text{psh1} * \text{Fywe1} + \text{ps2} * \text{Fywe2} = 1.25907$

ps1 (external) = $(\text{Ash1} * \text{h1} / \text{s1}) / \text{Asec} = 0.00156298$

Ash1 = $\text{Astir}_1 * \text{ns}_1 = 157.0796$

No stirups, ns_1 = 2.00

h1 = 400.00

ps2 (internal) = $(\text{Ash2} * \text{h2} / \text{s2}) / \text{Asec} = 0.00025008$

Ash2 = $\text{Astir}_2 * \text{ns}_2 = 100.531$

No stirups, ns_2 = 2.00

h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.4444

fywe2 = 694.4444

fce = 33.00

From ((5.A5), TBDY), TBDY: $c_c = 0.00232446$

c = confinement factor = 1.03245

y1 = 0.00097781

$sh1 = 0.003129$
 $ft1 = 325.9374$
 $fy1 = 271.6145$
 $su1 = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/ld = 0.17502824$
 $su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032$
 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 $fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 271.6145$
 with $Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00$
 $y2 = 0.00097781$
 $sh2 = 0.003129$
 $ft2 = 325.9374$
 $fy2 = 271.6145$
 $su2 = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/lb,min = 0.17502824$
 $su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032$
 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 $fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 271.6145$
 with $Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00$
 $yv = 0.00097781$
 $shv = 0.003129$
 $ftv = 325.9374$
 $fyv = 271.6145$
 $suv = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/ld = 0.17502824$
 $suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv, shv, 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 $fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 271.6145$
 with $Es_v = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.03135046$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.03135046$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.01913459$
 and confined core properties:
 $b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 34.07072$
 $cc (5A.5, TBDY) = 0.00232446$
 $c = \text{confinement factor} = 1.03245$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.0375932$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.0375932$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.02294481$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < vs,y2$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.20535904$

$$\begin{aligned} \mu &= MRC(4.14) = 9.1356E+007 \\ u &= su(4.1) = 1.1029765E-005 \end{aligned}$$

Calculation of ratio lb/l_d

$$\text{Lap Length: } lb/l_d = 0.17502824$$

$$lb = 300.00$$

$$l_d = 1714.009$$

Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

l_{d,min} from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$db = 15.23077$$

$$\text{Mean strength value of all re-bars: } f_y = 694.4444$$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$cb = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of μ_{2+}

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:

$$u = 1.1029765E-005$$

$$\mu = 9.1356E+007$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$c_o(5A.5, TBDY) = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00650344$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.00650344$$

$$w_e(5.4c) = 0.00563792$$

$$\text{ase((5.4d), TBDY) = (ase1*A_{ext} + ase2*A_{int})/A_{sec} = 0.14776895}$$

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

$$ho_1 = 610.00$$

$$bi_2_1 = 975400.00$$

$$ase2 = \text{Max}(ase1, ase2) = 0.14776895$$

$$bo_2 = 192.00$$

$$ho_2 = 492.00$$

$$bi_2_2 = 557856.00$$

$$psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.25907$$

$$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.25221$$

$$ps1(\text{external}) = (A_{sh1} * h1 / s1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * ns_1 = 157.0796$$

$$\text{No stirrups, } ns_1 = 2.00$$

$$h1 = 670.00$$

$$ps2(\text{internal}) = (A_{sh2} * h2 / s2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * ns_2 = 100.531$$

$$\text{No stirrups, } ns_2 = 2.00$$

$$h2 = 500.00$$

$$psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.25907$$

$$ps1(\text{external}) = (A_{sh1} * h1 / s1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * ns_1 = 157.0796$$

No stirups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2$ (internal) = $(Ash2*h2/s2)/Asec = 0.00025008$
 $Ash2 = Astir_2*ns_2 = 100.531$
No stirups, $ns_2 = 2.00$
 $h2 = 200.00$

 $Asec = 268000.00$
 $s1 = 150.00$
 $s2 = 300.00$
 $fywe1 = 694.4444$
 $fywe2 = 694.4444$
 $fce = 33.00$

From ((5.A.5), TBDY), TBDY: $cc = 0.00232446$
 $c =$ confinement factor = 1.03245

$y1 = 0.00097781$
 $sh1 = 0.003129$
 $ft1 = 325.9374$
 $fy1 = 271.6145$
 $su1 = 0.003129$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$lo/lou,min = lb/ld = 0.17502824$
 $su1 = 0.4*esu1_nominal$ ((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 $fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 271.6145$

with $Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00$

$y2 = 0.00097781$
 $sh2 = 0.003129$
 $ft2 = 325.9374$
 $fy2 = 271.6145$
 $su2 = 0.003129$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$lo/lou,min = lb/lb,min = 0.17502824$
 $su2 = 0.4*esu2_nominal$ ((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 $fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 271.6145$

with $Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00$

$yv = 0.00097781$
 $shv = 0.003129$
 $ftv = 325.9374$
 $fyv = 271.6145$
 $suv = 0.003129$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$lo/lou,min = lb/ld = 0.17502824$
 $suv = 0.4*esuv_nominal$ ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: $esuv_nominal = 0.08$,

considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY

For calculation of $esuv_nominal$ and yv, shv, 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 $fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 271.6145$

with $Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00$

$1 = Asl,ten/(b*d)*(fs1/fc) = 0.03135046$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.03135046$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.01913459$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$fcc \text{ (5A.2, TBDY)} = 34.07072$$

$$cc \text{ (5A.5, TBDY)} = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$1 = A_{sl,ten}/(b*d)*(fs1/fc) = 0.0375932$$

$$2 = A_{sl,com}/(b*d)*(fs2/fc) = 0.0375932$$

$$v = A_{sl,mid}/(b*d)*(fsv/fc) = 0.02294481$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$$s_u \text{ (4.9)} = 0.20535904$$

$$M_u = MR_c \text{ (4.14)} = 9.1356E+007$$

$$u = s_u \text{ (4.1)} = 1.1029765E-005$$

Calculation of ratio l_b/d

Lap Length: $l_b/d = 0.17502824$

$$l_b = 300.00$$

$$l_d = 1714.009$$

Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$d_b = 15.23077$$

Mean strength value of all re-bars: $f_y = 694.4444$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of M_{u2} -

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$$u = 1.1029765E-005$$

$$M_u = 9.1356E+007$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$c_o \text{ (5A.5, TBDY)} = 0.002$$

Final value of c_u : $c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00650344$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $c_u = 0.00650344$

$$w_e \text{ (5.4c)} = 0.00563792$$

$$a_{se} \text{ ((5.4d), TBDY)} = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$bi2_2 = 557856.00$$
$$psh,min*Fywe = \text{Min}(psh,x*Fywe, psh,y*Fywe) = 1.25907$$

$$psh_x*Fywe = psh1*Fywe1 + ps2*Fywe2 = 2.25221$$
$$ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00261799$$
$$Ash1 = Astir_1*ns_1 = 157.0796$$
$$\text{No stirups, } ns_1 = 2.00$$
$$h1 = 670.00$$
$$ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00062519$$
$$Ash2 = Astir_2*ns_2 = 100.531$$
$$\text{No stirups, } ns_2 = 2.00$$
$$h2 = 500.00$$

$$psh_y*Fywe = psh1*Fywe1 + ps2*Fywe2 = 1.25907$$
$$ps1 \text{ (external)} = (Ash1*h1/s1)/Asec = 0.00156298$$
$$Ash1 = Astir_1*ns_1 = 157.0796$$
$$\text{No stirups, } ns_1 = 2.00$$
$$h1 = 400.00$$
$$ps2 \text{ (internal)} = (Ash2*h2/s2)/Asec = 0.00025008$$
$$Ash2 = Astir_2*ns_2 = 100.531$$
$$\text{No stirups, } ns_2 = 2.00$$
$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 694.4444$$

$$fywe2 = 694.4444$$

$$fce = 33.00$$

$$\text{From } ((5.A.5), \text{ TBDY}), \text{ TBDY: } cc = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$y1 = 0.00097781$$

$$sh1 = 0.003129$$

$$ft1 = 325.9374$$

$$fy1 = 271.6145$$

$$su1 = 0.003129$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$lo/lou,min = lb/l_d = 0.17502824$$

$$su1 = 0.4*esu1_nominal \text{ ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } esu1_nominal = 0.08,$$

For calculation of esu1_nominal and y1, sh1, ft1, fy1, it is considered characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25*(lb/l_d)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 271.6145$$

$$\text{with } Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00$$

$$y2 = 0.00097781$$

$$sh2 = 0.003129$$

$$ft2 = 325.9374$$

$$fy2 = 271.6145$$

$$su2 = 0.003129$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$lo/lou,min = lb/l_b,min = 0.17502824$$

$$su2 = 0.4*esu2_nominal \text{ ((5.5), TBDY)} = 0.032$$

$$\text{From table 5A.1, TBDY: } esu2_nominal = 0.08,$$

For calculation of esu2_nominal and y2, sh2, ft2, fy2, it is considered characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25*(lb/l_d)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 271.6145$$

$$\text{with } Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00$$

$$yv = 0.00097781$$

$$shv = 0.003129$$

$$ftv = 325.9374$$

$$fyv = 271.6145$$

$$suv = 0.003129$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou,min = lb/ld = 0.17502824$$

$$suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY

For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

$$y1, sh1,ft1,fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (lb/ld)^{2/3}), \text{ from } 10.3.5, \text{ ASCE } 41-17.$$

$$\text{with } fsv = (fs_jacket * Asl_mid_jacket + fs_mid * Asl_mid_core) / Asl_mid = 271.6145$$

$$\text{with } Esv = (Es_jacket * Asl_mid_jacket + Es_mid * Asl_mid_core) / Asl_mid = 200000.00$$

$$1 = Asl_ten / (b * d) * (fs1 / fc) = 0.03135046$$

$$2 = Asl_com / (b * d) * (fs2 / fc) = 0.03135046$$

$$v = Asl_mid / (b * d) * (fsv / fc) = 0.01913459$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 34.07072$$

$$cc (5A.5, TBDY) = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$1 = Asl_ten / (b * d) * (fs1 / fc) = 0.0375932$$

$$2 = Asl_com / (b * d) * (fs2 / fc) = 0.0375932$$

$$v = Asl_mid / (b * d) * (fsv / fc) = 0.02294481$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

v < vs,y2 - LHS eq.(4.5) is satisfied

--->

$$su (4.9) = 0.20535904$$

$$Mu = MRc (4.14) = 9.1356E+007$$

$$u = su (4.1) = 1.1029765E-005$$

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.17502824

$$lb = 300.00$$

$$ld = 1714.009$$

Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$db = 15.23077$$

Mean strength value of all re-bars: fy = 694.4444

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$cb = 25.00$$

$$Ktr = 2.64216$$

$$n = 13.00$$

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 383229.931

Calculation of Shear Strength at edge 1, Vr1 = 383229.931

$$Vr1 = Vn ((22.5.1.1), ACI 318-14)$$

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f*Vf'

where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: Vc = 197061.477

= 1 (normal-weight concrete)

$$\text{Mean concrete strength: } fc' = (fc_jacket * Area_jacket + fc_core * Area_core) / Area_section = 33.00, \text{ but } fc'^{0.5} \leq 8.3$$

MPa (22.5.3.1, ACI 318-14)

$$pw = As/(bw*d) = 0.00331157$$

$$As \text{ (tension reinf.)} = 709.9999$$

$$bw = 670.00$$

$$d = 320.00$$

$$Vu*d/Mu < 1 = 0.00$$

$$Mu = 2.6257021E-011$$

$$Vu = 2.6375953E-014$$

From (11.5.4.8), ACI 318-14: $Vs1 + Vs2 = 186168.454$

$Vs1 = 186168.454$ is calculated for jacket, with:

$$d = 320.00$$

$$Av = 157079.633$$

$$fy = 555.5556$$

$$s = 150.00$$

$Vs1$ has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$Vs2 = 0.00$ is calculated for jacket, with:

$$d2 = 160.00$$

$$Av = 100530.965$$

$$fy = 555.5556$$

$$s = 300.00$$

$Vs2$ is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)

$$Vf \text{ ((11-3)-(11.4), ACI 440)} = 0.00$$

$$\text{From (11-11), ACI 440: } Vs + Vf \leq 818179.336$$

Calculation of Shear Strength at edge 2, $Vr2 = 383229.931$

$$Vr2 = Vn \text{ ((22.5.1.1), ACI 318-14)}$$

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f*Vf' where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $Vc = 197061.477$

= 1 (normal-weight concrete)

Mean concrete strength: $fc' = (fc'_{\text{jacket}} * Area_{\text{jacket}} + fc'_{\text{core}} * Area_{\text{core}}) / Area_{\text{section}} = 33.00$, but $fc'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$$pw = As/(bw*d) = 0.00331157$$

$$As \text{ (tension reinf.)} = 709.9999$$

$$bw = 670.00$$

$$d = 320.00$$

$$Vu*d/Mu < 1 = 0.00$$

$$Mu = 5.2870952E-011$$

$$Vu = 2.6375953E-014$$

From (11.5.4.8), ACI 318-14: $Vs1 + Vs2 = 186168.454$

$Vs1 = 186168.454$ is calculated for jacket, with:

$$d = 320.00$$

$$Av = 157079.633$$

$$fy = 555.5556$$

$$s = 150.00$$

$Vs1$ has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$Vs2 = 0.00$ is calculated for jacket, with:

$$d = 160.00$$

$$Av = 100530.965$$

$$fy = 555.5556$$

$$s = 300.00$$

$Vs2$ is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)

$$Vf \text{ ((11-3)-(11.4), ACI 440)} = 0.00$$

$$\text{From (11-11), ACI 440: } Vs + Vf \leq 818179.336$$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (b)

Section Type: rcjars

Constant Properties

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, $f_s = f_{sm} = 555.5556$

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

Existing Column

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 33.00$

New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.5556$

Concrete Elasticity, $E_c = 26999.444$

Steel Elasticity, $E_s = 200000.00$

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Smooth Bars

Ductile Steel

With Detailing for Earthquake Resistance (including stirrups closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_b = 300.00$

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 1.8842E+007$

Shear Force, $V_2 = -1.2862848E-013$

Shear Force, $V_3 = 20600.458$

Axial Force, $F = -4784.664$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{sl,t} = 709.9999$

-Compression: $A_{sl,c} = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{sl,ten} = 709.9999$

-Compression: $A_{sl,com} = 1266.062$

-Middle: $A_{sl,mid} = 402.1239$

Longitudinal External Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{sl,ten,jacket} = 402.1239$

-Compression: $A_{sl,com,jacket} = 804.2477$

-Middle: $A_{sl,mid,jacket} = 402.1239$

Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{sl,ten,core} = 307.8761$

-Compression: $A_{sl,com,core} = 461.8141$

-Middle: $A_{sl,mid,core} = 0.00$

Mean Diameter of Tension Reinforcement, $DbL = 15.00$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_{,R} = 1.0^*$ $u = 0.02046936$

$u = y + p = 0.02046936$

- Calculation of y -

$y = (My * L_s / 3) / E_{eff} = 0.00046936$ ((4.29), Biskinis Phd))

$My = 1.2501E+008$

$L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 914.6453

From table 10.5, ASCE 41_17: $E_{eff} = 0.3 * E_c * I_g = 8.1204E+013$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$

$y_{ten} = 2.4698669E-006$

with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25 * f_y * (l_b/d)^{2/3}) = 252.1446$

$d = 627.00$

$y = 0.18589856$

$A = 0.00955806$

$B = 0.00410947$

with $pt = 0.00283094$

$pc = 0.00504809$

$pv = 0.00160336$

$N = 4784.664$

$b = 400.00$

" = 0.06858054

$y_{comp} = 1.9034257E-005$

with $f_c = 33.00$

$E_c = 26999.444$

$y = 0.18434363$

$A = 0.00943904$

$B = 0.0040338$

with $E_s = 200000.00$

Calculation of ratio l_b/d

Lap Length: $l_d/d_{min} = 0.2187853$

$l_b = 300.00$

$l_d = 1371.207$

Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)

= 1

$db = 15.23077$

Mean strength value of all re-bars: $f_y = 555.5556$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

- Calculation of p -

From table 10-7: $p = 0.02$

with:

- Condition iv occurred

Beam controlled by inadequate embedment into beam-column joint:

($l_b/d < 1$ and With Lapping in the Vicinity of the End Regions

- Condition i occurred

Beam controlled by flexure: $V_p/V_o \leq 1$

shear control ratio $V_p/V_o = 0.2867466$

- Transverse Reinforcement: C

- Stirrup Spacing $\leq d/3$

- Low ductility demand, $f_y / y < 2$ (table 10-6, ASCE 41-17)

= 1.5669883E-005

- Stirrup Spacing $\leq d/2$

$d = d_{external} = 627.00$

$s = s_{external} = 150.00$

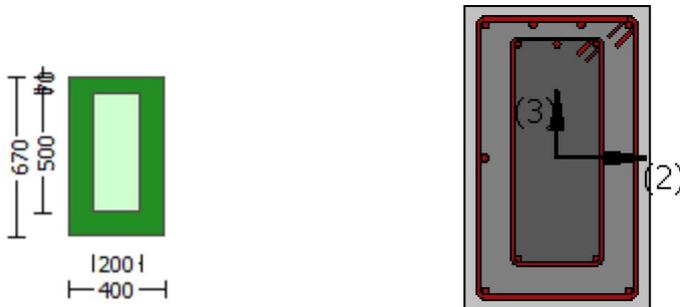
- Strength provided by hoops $V_s < 3/4 * \text{design Shear}$

$V_s = 386299.541$, already given in calculation of shear control ratio
 design Shear = 20600.458
 $\rho = \rho_{bal} = -0.22420383$
 $\rho = A_{st}/(b_w*d) = 0.00283094$
 Tension Reinf Area: $A_{st} = 709.9999$
 $\rho' = A_{sc}/(b_w*d) = 0.00665146$
 Compression Reinf Area: $A_{sc} = 1668.186$
 From (B-1), ACI 318-11: $\rho_{bal} = 0.01704038$
 $f_c = (f_{c_jacket}*Area_jacket + f_{c_core}*Area_core)/section_area = 33.00$
 $f_y = f_{y_jacket_bars} = 555.5556$
 From 10.2.7.3, ACI 318-11: $\beta_1 = 0.65$
 From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000/(87000 + f_y) = c_b/d_t = 0.003/(0.003 + \rho) = 0.51923077$
 $\rho_y = 0.00277778$
 $V/(b_w*d*f_c^{0.5}) = 0.17219304$, NOTE: units in lb & in
 $b_w = 400.00$

 End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1
 At local axis: 2
 Integration Section: (b)

Calculation No. 15

beam B1, Floor 1
 Limit State: Life Safety (data interpolation between analysis steps 1 and 2)
 Analysis: Uniform +X
 Check: Shear capacity V_{Rd}
 Edge: End
 Local Axis: (3)



Start Of Calculation of Shear Capacity for element: beam JB1 of floor 1
 At local axis: 3
 Integration Section: (b)
 Section Type: rcjars
 Constant Properties

Knowledge Factor, $\phi = 1.00$
 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
 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, $E_s = 200000.00$
 External Height, $H = 670.00$
 External Width, $W = 400.00$
 Internal Height, $H = 500.00$
 Internal Width, $W = 200.00$
 Cover Thickness, $c = 25.00$
 Element Length, $L = 3000.00$
 Secondary Member
 Smooth Bars
 Ductile Steel
 With Detailing for Earthquake Resistance (including stirrups closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Lap Length $l_o = l_b = 300.00$
 No FRP Wrapping

Stepwise Properties

EDGE -A-
 Bending Moment, $M_a = 1.3438E+007$
 Shear Force, $V_a = -919.1918$
 EDGE -B-
 Bending Moment, $M_b = 1.8842E+007$
 Shear Force, $V_b = 20600.458$
 BOTH EDGES
 Axial Force, $F = -4784.664$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $A_{sl} = 709.9999$
 -Compression: $A_{sc} = 1668.186$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $A_{sl,ten} = 709.9999$
 -Compression: $A_{sl,com} = 1266.062$
 -Middle: $A_{sl,mid} = 402.1239$
 Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 15.00$

New component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = 1.0 \cdot V_n = 492752.521$
 V_n ((22.5.1.1), ACI 318-14) = 492752.521

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ '
 where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 178593.255$
 $= 1$ (normal-weight concrete)
 Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot Area_{jacket} + f'_{c_core} \cdot Area_{core}) / Area_{section} = 25.00$, but $f_c^{0.5} \leq 8.3$
 MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 400.00$
 $d = 536.00$
 $V_u \cdot d / \mu_u < 1 = 0.58601953$

$$M_u = 1.8842E+007$$

$$V_u = 20600.458$$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 314159.265$

$V_{s1} = 280648.944$ is calculated for jacket, with:

$$d = 536.00$$

$$A_v = 157079.633$$

$$f_y = 500.00$$

$$s = 150.00$$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 33510.322$ is calculated for core, with:

$$d = 400.00$$

$$A_v = 100530.965$$

$$f_y = 500.00$$

$$s = 300.00$$

V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.50$$

$$V_f ((11-3)-(11.4), ACI 440) = 0.00$$

$$\text{From } (11-11), ACI 440: V_s + V_f \leq 712133.705$$

End Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (b)

Calculation No. 16

beam B1, Floor 1

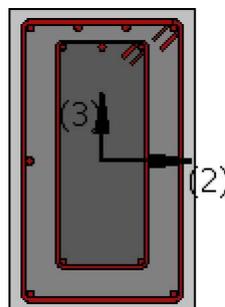
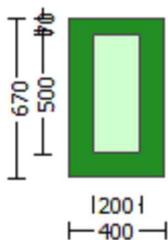
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (u)

Edge: End

Local Axis: (3)



Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\phi = 1.00$
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, $f_s = f_{sm} = 555.5556$
Concrete Elasticity, $E_c = 26999.444$
Steel Elasticity, $E_s = 200000.00$
Existing Column
New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.5556$
Concrete Elasticity, $E_c = 26999.444$
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, $f_s = 1.25 * f_{sm} = 694.4444$
Existing Column
New material: Steel Strength, $f_s = 1.25 * f_{sm} = 694.4444$

External Height, $H = 670.00$
External Width, $W = 400.00$
Internal Height, $H = 500.00$
Internal Width, $W = 200.00$
Cover Thickness, $c = 25.00$
Mean Confinement Factor overall section = 1.03245
Element Length, $L = 3000.00$
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length $l_o = 300.00$
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, $V_a = 9840.633$
EDGE -B-
Shear Force, $V_b = 9840.633$
BOTH EDGES
Axial Force, $F = -2237.255$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{sl,t} = 709.9999$
-Compression: $A_{sl,c} = 1668.186$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{sl,ten} = 709.9999$
-Compression: $A_{sl,com} = 1266.062$
-Middle: $A_{sl,mid} = 402.1239$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.2867466$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u * l_n / 2 = 160061.187$
with
 $M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 2.2533E+008$
 $M_{u1+} = 1.1683E+008$, 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
 $M_{u1-} = 2.2533E+008$, 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

$$M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 2.2533E+008$$

$M_{u2+} = 1.1683E+008$, 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

$M_{u2-} = 2.2533E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination

and

$$\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$$

with

$V_1 = 9840.633$, is the shear force acting at edge 1 for the static loading combination

$V_2 = 9840.633$, is the shear force acting at edge 2 for the static loading combination

Calculation of M_{u1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$$\phi_u = 6.1426221E-006$$

$$M_u = 1.1683E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$c_o \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} \cdot \text{Max}(\phi_{cu}, \phi_{cc}) = 0.00650344$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.00650344$$

$$\omega_e \text{ (5.4c)} = 0.00563792$$

$$a_{se} \text{ ((5.4d), TBDY)} = (a_{se1} \cdot A_{ext} + a_{se2} \cdot A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh, \min} \cdot F_{ywe} = \text{Min}(p_{sh, x} \cdot F_{ywe}, p_{sh, y} \cdot F_{ywe}) = 1.25907$$

 $p_{sh, x} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{s2} \cdot F_{ywe2} = 2.25221$

$$p_{s1} \text{ (external)} = (A_{sh1} \cdot h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} \cdot n_{s_1} = 157.0796$$

$$\text{No stirups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} \cdot h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} \cdot n_{s_2} = 100.531$$

$$\text{No stirups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

 $p_{sh, y} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{s2} \cdot F_{ywe2} = 1.25907$

$$p_{s1} \text{ (external)} = (A_{sh1} \cdot h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} \cdot n_{s_1} = 157.0796$$

$$\text{No stirups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} \cdot h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} \cdot n_{s_2} = 100.531$$

$$\text{No stirups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

 $A_{sec} = 268000.00$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.4444$$

$$fy_{we2} = 694.4444$$

$$f_{ce} = 33.00$$

From ((5.A.5), TBDY), TBDY: $cc = 0.00232446$

$$c = \text{confinement factor} = 1.03245$$

$$y_1 = 0.00097781$$

$$sh_1 = 0.003129$$

$$ft_1 = 325.9374$$

$$fy_1 = 271.6145$$

$$su_1 = 0.003129$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/ld = 0.17502824$$

$$su_1 = 0.4 * esu_{1, \text{nominal}} ((5.5), \text{TBDY}) = 0.032$$

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.

$$\text{with } fs_1 = (fs_{\text{jacket}} * Asl, \text{ten, jacket} + fs_{\text{core}} * Asl, \text{ten, core}) / Asl, \text{ten} = 271.6145$$

$$\text{with } Es_1 = (Es_{\text{jacket}} * Asl, \text{ten, jacket} + Es_{\text{core}} * Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$$

$$y_2 = 0.00097781$$

$$sh_2 = 0.003129$$

$$ft_2 = 325.9374$$

$$fy_2 = 271.6145$$

$$su_2 = 0.003129$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/lb, \min = 0.17502824$$

$$su_2 = 0.4 * esu_{2, \text{nominal}} ((5.5), \text{TBDY}) = 0.032$$

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.

$$\text{with } fs_2 = (fs_{\text{jacket}} * Asl, \text{com, jacket} + fs_{\text{core}} * Asl, \text{com, core}) / Asl, \text{com} = 271.6145$$

$$\text{with } Es_2 = (Es_{\text{jacket}} * Asl, \text{com, jacket} + Es_{\text{core}} * Asl, \text{com, core}) / Asl, \text{com} = 200000.00$$

$$y_v = 0.00097781$$

$$sh_v = 0.003129$$

$$ft_v = 325.9374$$

$$fy_v = 271.6145$$

$$suv = 0.003129$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/ld = 0.17502824$$

$$suv = 0.4 * esuv_{\text{nominal}} ((5.5), \text{TBDY}) = 0.032$$

From table 5A.1, TBDY: $esuv_{\text{nominal}} = 0.08$,

considering characteristic value $fsyv = fsv/1.2$, 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 $fsyv = fsv/1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fsv = (fs_{\text{jacket}} * Asl, \text{mid, jacket} + fs_{\text{mid}} * Asl, \text{mid, core}) / Asl, \text{mid} = 271.6145$$

$$\text{with } Es_v = (Es_{\text{jacket}} * Asl, \text{mid, jacket} + Es_{\text{mid}} * Asl, \text{mid, core}) / Asl, \text{mid} = 200000.00$$

$$1 = Asl, \text{ten} / (b * d) * (fs_1 / f_c) = 0.02330074$$

$$2 = Asl, \text{com} / (b * d) * (fs_2 / f_c) = 0.04154956$$

$$v = Asl, \text{mid} / (b * d) * (fsv / f_c) = 0.01319688$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc (5A.2, \text{TBDY}) = 34.07072$$

$$cc (5A.5, \text{TBDY}) = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$1 = Asl, \text{ten} / (b * d) * (fs_1 / f_c) = 0.02879016$$

$$2 = Asl, \text{com} / (b * d) * (fs_2 / f_c) = 0.0513382$$

$$v = Asl, \text{mid} / (b * d) * (fsv / f_c) = 0.01630593$$

Case/Assumption: Unconfinedsd full section - Steel rupture

satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$$s_u(4.9) = 0.18757351$$

$$\mu_u = M_{Rc}(4.14) = 1.1683E+008$$

$$u = s_u(4.1) = 6.1426221E-006$$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.17502824$

$$l_b = 300.00$$

$$l_d = 1714.009$$

Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$d_b = 15.23077$$

$$\text{Mean strength value of all re-bars: } f_y = 694.4444$$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of μ_{u1} -

Calculation of ultimate curvature μ_u according to 4.1, Biskinis/Fardis 2013:

$$u = 6.3198187E-006$$

$$\mu_u = 2.2533E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$c_o(5A.5, \text{TBDY}) = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00650344$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.00650344$$

$$w_e(5.4c) = 0.00563792$$

$$\text{ase}((5.4d), \text{TBDY}) = (\text{ase}_1 * A_{ext} + \text{ase}_2 * A_{int}) / A_{sec} = 0.14776895$$

$$\text{ase}_1 = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$\text{ase}_2 = \text{Max}(\text{ase}_1, \text{ase}_2) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh,min} * F_{ywe} = \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.25907$$

$$p_{sh,x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.25221$$

$$p_{s1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2}(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirups, } n_{s_2} = 2.00$$

$$h2 = 500.00$$

$$\begin{aligned} psh_y * Fywe &= psh1 * Fywe1 + ps2 * Fywe2 = 1.25907 \\ ps1 \text{ (external)} &= (Ash1 * h1 / s1) / Asec = 0.00156298 \\ Ash1 &= Astir_1 * ns_1 = 157.0796 \\ \text{No stirups, } ns_1 &= 2.00 \\ h1 &= 400.00 \\ ps2 \text{ (internal)} &= (Ash2 * h2 / s2) / Asec = 0.00025008 \\ Ash2 &= Astir_2 * ns_2 = 100.531 \\ \text{No stirups, } ns_2 &= 2.00 \\ h2 &= 200.00 \end{aligned}$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 694.4444$$

$$fywe2 = 694.4444$$

$$fce = 33.00$$

$$\text{From } ((5.A.5), \text{ TBDY}), \text{ TBDY: } cc = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$y1 = 0.00097781$$

$$sh1 = 0.003129$$

$$ft1 = 325.9374$$

$$fy1 = 271.6145$$

$$su1 = 0.003129$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \text{min} = lb/ld = 0.17502824$$

$$su1 = 0.4 * esu1_nominal \text{ ((5.5), TBDY)} = 0.032$$

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.

$$\text{with } fs1 = (fs_jacket * Asl, \text{ten, jacket} + fs_core * Asl, \text{ten, core}) / Asl, \text{ten} = 271.6145$$

$$\text{with } Es1 = (Es_jacket * Asl, \text{ten, jacket} + Es_core * Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$$

$$y2 = 0.00097781$$

$$sh2 = 0.003129$$

$$ft2 = 325.9374$$

$$fy2 = 271.6145$$

$$su2 = 0.003129$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \text{min} = lb/lb, \text{min} = 0.17502824$$

$$su2 = 0.4 * esu2_nominal \text{ ((5.5), TBDY)} = 0.032$$

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.

$$\text{with } fs2 = (fs_jacket * Asl, \text{com, jacket} + fs_core * Asl, \text{com, core}) / Asl, \text{com} = 271.6145$$

$$\text{with } Es2 = (Es_jacket * Asl, \text{com, jacket} + Es_core * Asl, \text{com, core}) / Asl, \text{com} = 200000.00$$

$$yv = 0.00097781$$

$$shv = 0.003129$$

$$ftv = 325.9374$$

$$fyv = 271.6145$$

$$suv = 0.003129$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \text{min} = lb/ld = 0.17502824$$

$$suv = 0.4 * esuv_nominal \text{ ((5.5), TBDY)} = 0.032$$

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv, ftv, fyv, it is considered

characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1, ft1, fy1, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $f_{sv} = (f_{s,jacket} \cdot A_{sl,mid,jacket} + f_{s,mid} \cdot A_{sl,mid,core}) / A_{sl,mid} = 271.6145$
 with $E_{sv} = (E_{s,jacket} \cdot A_{sl,mid,jacket} + E_{s,mid} \cdot A_{sl,mid,core}) / A_{sl,mid} = 200000.00$
 $1 = A_{sl,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.04154956$
 $2 = A_{sl,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.02330074$
 $v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.01319688$

and confined core properties:

$b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 34.07072$
 $cc (5A.5, TBDY) = 0.00232446$
 $c = \text{confinement factor} = 1.03245$
 $1 = A_{sl,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.0513382$
 $2 = A_{sl,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.02879016$
 $v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.01630593$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$\mu (4.9) = 0.21035251$
 $\mu = M_{Rc} (4.14) = 2.2533E+008$
 $u = \mu (4.1) = 6.3198187E-006$

Calculation of ratio l_b / l_d

Lap Length: $l_b / l_d = 0.17502824$

$l_b = 300.00$
 $l_d = 1714.009$

Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$= 1$
 $db = 15.23077$
 Mean strength value of all re-bars: $f_y = 694.4444$
 $t = 1.16154$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.64216$
 $n = 13.00$

Calculation of μ_{2+}

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$u = 6.1426221E-006$
 $\mu = 1.1683E+008$

with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.00027032$
 $N = 2237.255$
 $f_c = 33.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of μ : $\mu^* = \text{shear_factor} \cdot \text{Max}(\mu, co) = 0.00650344$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $\mu = 0.00650344$
 $w_e (5.4c) = 0.00563792$
 $ase ((5.4d), TBDY) = (ase1 \cdot A_{ext} + ase2 \cdot A_{int}) / A_{sec} = 0.14776895$
 $ase1 = 0.14776895$
 $bo_1 = 340.00$

ho_1 = 610.00
bi2_1 = 975400.00
ase2 = Max(ase1,ase2) = 0.14776895
bo_2 = 192.00
ho_2 = 492.00
bi2_2 = 557856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.25907

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.25221
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.25907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 268000.00
s1 = 150.00
s2 = 300.00
fywe1 = 694.4444
fywe2 = 694.4444
fce = 33.00

From ((5.A.5), TBDY), TBDY: cc = 0.00232446
c = confinement factor = 1.03245

y1 = 0.00097781
sh1 = 0.003129
ft1 = 325.9374
fy1 = 271.6145
su1 = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.17502824
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,min)^ 2/3), from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 271.6145

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.00097781
sh2 = 0.003129
ft2 = 325.9374
fy2 = 271.6145
su2 = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.17502824
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,min)^ 2/3), from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 271.6145

with $E_{s2} = (E_{s,jacket} \cdot A_{s,com,jacket} + E_{s,core} \cdot A_{s,com,core}) / A_{s,com} = 200000.00$
 $y_v = 0.000977781$
 $sh_v = 0.003129$
 $ft_v = 325.9374$
 $fy_v = 271.6145$
 $su_v = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{o,min} = l_b/l_d = 0.17502824$
 $su_v = 0.4 \cdot esuv_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fs_y = f_{sv}/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fs_y = f_{sv}/1.2$, 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 $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 271.6145$
 with $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.02330074$
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.04154956$
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.01319688$

and confined core properties:

$b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 34.07072$
 $cc (5A.5, TBDY) = 0.00232446$
 $c = \text{confinement factor} = 1.03245$
 $1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.02879016$
 $2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.0513382$
 $v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.01630593$

Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.18757351$
 $Mu = MRc (4.14) = 1.1683E+008$
 $u = su (4.1) = 6.1426221E-006$

 Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.17502824$
 $l_b = 300.00$
 $l_d = 1714.009$
 Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 15.23077$
 Mean strength value of all re-bars: $fy = 694.4444$
 $t = 1.16154$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.64216$
 $n = 13.00$

 Calculation of Mu_2 -

 Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 6.3198187E-006$
 $Mu = 2.2533E+008$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00027032$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$c_o (5A.5, TBDY) = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00650344$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.00650344$$

$$w_e (5.4c) = 0.00563792$$

$$a_{se} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25907$$

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.25221$$

$$p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.25907$$

$$p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$p_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.4444$$

$$f_{ywe2} = 694.4444$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A.5), TBDY), TBDY: } c_c = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$y_1 = 0.00097781$$

$$sh_1 = 0.003129$$

$$ft_1 = 325.9374$$

$$fy_1 = 271.6145$$

$$su_1 = 0.003129$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$$l_o / l_{ou, \min} = l_b / d = 0.17502824$$

$$su_1 = 0.4 * esu_{1, \text{nominal}} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esu_{1, \text{nominal}} = 0.08$,

For calculation of $esu_{1, \text{nominal}}$ and y_1, sh_1, ft_1, fy_1 , it is considered characteristic value $fsy_1 = fs_1 / 1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b / d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_1 = (fs_{\text{jacket}} * A_{sl, \text{ten, jacket}} + fs_{\text{core}} * A_{sl, \text{ten, core}}) / A_{sl, \text{ten}} = 271.6145$$

with $E_{s1} = (E_{s,jacket} \cdot A_{s,ten,jacket} + E_{s,core} \cdot A_{s,ten,core}) / A_{s,ten} = 200000.00$
 $y_2 = 0.00097781$
 $sh_2 = 0.003129$
 $ft_2 = 325.9374$
 $fy_2 = 271.6145$
 $su_2 = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_0/l_{ou,min} = l_b/l_{b,min} = 0.17502824$
 $su_2 = 0.4 \cdot esu_{2,nominal} ((5.5), TBDY) = 0.032$
 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 $fs_2 = fs_2/1.2$, 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 $fs_2 = (fs_{jacket} \cdot A_{s,com,jacket} + fs_{core} \cdot A_{s,com,core}) / A_{s,com} = 271.6145$
 with $E_{s2} = (E_{s,jacket} \cdot A_{s,com,jacket} + E_{s,core} \cdot A_{s,com,core}) / A_{s,com} = 200000.00$
 $y_v = 0.00097781$
 $sh_v = 0.003129$
 $ft_v = 325.9374$
 $fy_v = 271.6145$
 $suv = 0.003129$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_0/l_{ou,min} = l_b/l_d = 0.17502824$
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fs_v = fs_v/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fs_v = fs_v/1.2$, 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 $fs_v = (fs_{jacket} \cdot A_{s,mid,jacket} + fs_{mid} \cdot A_{s,mid,core}) / A_{s,mid} = 271.6145$
 with $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$
 $1 = A_{s,ten} / (b \cdot d) \cdot (fs_1 / f_c) = 0.04154956$
 $2 = A_{s,com} / (b \cdot d) \cdot (fs_2 / f_c) = 0.02330074$
 $v = A_{s,mid} / (b \cdot d) \cdot (fs_v / f_c) = 0.01319688$

and confined core properties:

$b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 34.07072$
 $cc (5A.5, TBDY) = 0.00232446$
 $c = \text{confinement factor} = 1.03245$
 $1 = A_{s,ten} / (b \cdot d) \cdot (fs_1 / f_c) = 0.0513382$
 $2 = A_{s,com} / (b \cdot d) \cdot (fs_2 / f_c) = 0.02879016$
 $v = A_{s,mid} / (b \cdot d) \cdot (fs_v / f_c) = 0.01630593$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

---->

$v < v_s, y_2$ - LHS eq.(4.5) is satisfied

---->

$su (4.9) = 0.21035251$
 $M_u = MR_c (4.14) = 2.2533E+008$
 $u = su (4.1) = 6.3198187E-006$

 Calculation of ratio l_b/l_d

 Lap Length: $l_b/l_d = 0.17502824$

$l_b = 300.00$

$l_d = 1714.009$

Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

$db = 15.23077$

Mean strength value of all re-bars: $fy = 694.4444$

t = 1.16154
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.64216
n = 13.00

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 558197.326$

Calculation of Shear Strength at edge 1, $V_{r1} = 558197.326$
 $V_{r1} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 209131.476$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot \text{Area}_{jacket} + f'_{c_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 33.00$, but $f'_c^{0.5} \leq 8.3$
MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
As (tension reinf.) = 709.9999
b_w = 400.00
d = 536.00
 $V_u \cdot d / \mu_u < 1 = 1.00$
 $\mu_u = 1.0197E+006$
 $V_u = 9840.633$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 349065.85$
 $V_{s1} = 311832.16$ is calculated for jacket, with:

d = 536.00
 $A_v = 157079.633$
 $f_y = 555.5556$
s = 150.00

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 37233.691$ is calculated for jacket, with:

d2 = 400.00
 $A_v = 100530.965$
 $f_y = 555.5556$
s = 300.00

V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.50$

V_f ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: $V_s + V_f \leq 818179.336$

Calculation of Shear Strength at edge 2, $V_{r2} = 558197.326$
 $V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 209131.476$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot \text{Area}_{jacket} + f'_{c_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 33.00$, but $f'_c^{0.5} \leq 8.3$
MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
As (tension reinf.) = 709.9999
b_w = 400.00
d = 536.00
 $V_u \cdot d / \mu_u < 1 = 1.00$
 $\mu_u = 1.0197E+006$
 $V_u = 9840.633$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 349065.85$

$V_{s1} = 311832.16$ is calculated for jacket, with:

d = 536.00
 $A_v = 157079.633$

fy = 555.5556

s = 150.00

Vs1 has been multiplied by 1 (s<d/2, according to ASCE 41-17,10.3.4)

Vs2 = 37233.691 is calculated for jacket, with:

d = 400.00

Av = 100530.965

fy = 555.5556

s = 300.00

Vs2 has been multiplied by 2(1-s/d) (s>d/2, according to ASCE 41-17,10.3.4)

2(1-s/d) = 0.50

Vf ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: Vs + Vf <= 818179.336

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 2

(Bending local axis: 3)

Section Type: rcjars

Constant Properties

Knowledge Factor, = 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 = 555.5556

Concrete Elasticity, Ec = 26999.444

Steel Elasticity, Es = 200000.00

Existing Column

New material of Secondary Member: Concrete Strength, fc = fcm = 33.00

New material of Secondary Member: Steel Strength, fs = fsm = 555.5556

Concrete Elasticity, Ec = 26999.444

Steel Elasticity, Es = 200000.00

#####

Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

New material: Steel Strength, fs = 1.25*fsm = 694.4444

Existing Column

New material: Steel Strength, fs = 1.25*fsm = 694.4444

#####

External Height, H = 670.00

External Width, W = 400.00

Internal Height, H = 500.00

Internal Width, W = 200.00

Cover Thickness, c = 25.00

Mean Confinement Factor overall section = 1.03245

Element Length, L = 3000.00

Secondary Member

Smooth Bars

Ductile Steel

With Detailing for Earthquake Resistance (including stirrups closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length lo = 300.00

No FRP Wrapping

Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force, $V_a = -2.6375953E-014$

EDGE -B-

Shear Force, $V_b = 2.6375953E-014$

BOTH EDGES

Axial Force, $F = -2237.255$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{st} = 709.9999$

-Compression: $A_{sc} = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{st,ten} = 911.0619$

-Compression: $A_{sc,com} = 911.0619$

-Middle: $A_{st,mid} = 556.0619$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.15892241$

Member Controlled by Flexure ($V_e/V_r < 1$)

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 60903.823$

with

$M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 9.1356E+007$

$M_{u1+} = 9.1356E+007$, 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

$M_{u1-} = 9.1356E+007$, 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

$M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 9.1356E+007$

$M_{u2+} = 9.1356E+007$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination

$M_{u2-} = 9.1356E+007$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

and

$\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$

with

$V_1 = -2.6375953E-014$, is the shear force acting at edge 1 for the the static loading combination

$V_2 = 2.6375953E-014$, is the shear force acting at edge 2 for the the static loading combination

Calculation of M_{u1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$\phi_u = 1.1029765E-005$

$M_u = 9.1356E+007$

with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.00028344$

$N = 2237.255$

$f_c = 33.00$

ϕ_c (5A.5, TBDY) = 0.002

Final value of ϕ_u : $\phi_u^* = \text{shear_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.00650344$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $\phi_u = 0.00650344$

w_e (5.4c) = 0.00563792

a_{se} ((5.4d), TBDY) = $(a_{se1} \cdot A_{ext} + a_{se2} \cdot A_{int})/A_{sec} = 0.14776895$

$a_{se1} = 0.14776895$

$b_{o_1} = 340.00$

$h_{o_1} = 610.00$

$b_{i2_1} = 975400.00$

$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$

$b_{o_2} = 192.00$

$h_{o_2} = 492.00$

$b_{i2_2} = 557856.00$

$\text{psh}_{\min} \cdot F_{ywe} = \text{Min}(\text{psh}_{x} \cdot F_{ywe}, \text{psh}_{y} \cdot F_{ywe}) = 1.25907$

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.25221
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.25907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.4444

fywe2 = 694.4444

fce = 33.00

From ((5.A5), TBDY), TBDY: cc = 0.00232446

c = confinement factor = 1.03245

y1 = 0.00097781

sh1 = 0.003129

ft1 = 325.9374

fy1 = 271.6145

su1 = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 0.17502824

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 $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 271.6145

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.00097781

sh2 = 0.003129

ft2 = 325.9374

fy2 = 271.6145

su2 = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.17502824

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 $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 271.6145

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.00097781

shv = 0.003129

ftv = 325.9374

fyv = 271.6145

suv = 0.003129

using (30) in Biskinis/Fardis (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/d = 0.17502824

su = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY

For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

with fsv = (fsjacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 271.6145

with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.03135046

2 = Asl,com/(b*d)*(fs2/fc) = 0.03135046

v = Asl,mid/(b*d)*(fsv/fc) = 0.01913459

and confined core properties:

b = 610.00

d = 327.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07072

cc (5A.5, TBDY) = 0.00232446

c = confinement factor = 1.03245

1 = Asl,ten/(b*d)*(fs1/fc) = 0.0375932

2 = Asl,com/(b*d)*(fs2/fc) = 0.0375932

v = Asl,mid/(b*d)*(fsv/fc) = 0.02294481

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

v < vs,y2 - LHS eq.(4.5) is satisfied

--->

su (4.9) = 0.20535904

Mu = MRc (4.14) = 9.1356E+007

u = su (4.1) = 1.1029765E-005

Calculation of ratio lb/d

Lap Length: lb/d = 0.17502824

lb = 300.00

ld = 1714.009

Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

db = 15.23077

Mean strength value of all re-bars: fy = 694.4444

t = 1.16154

s = 0.80

e = 1.00

cb = 25.00

Ktr = 2.64216

n = 13.00

Calculation of Mu1-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

u = 1.1029765E-005

Mu = 9.1356E+007

with full section properties:

b = 670.00

d = 357.00

d' = 43.00

v = 0.00028344

N = 2237.255

fc = 33.00

cc (5A.5, TBDY) = 0.002

Final value of cu: $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00650344$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $cu = 0.00650344$

we (5.4c) = 0.00563792

ase ((5.4d), TBDY) = $(ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$

ase1 = 0.14776895

bo_1 = 340.00

ho_1 = 610.00

bi2_1 = 975400.00

ase2 = $\text{Max}(ase1, ase2) = 0.14776895$

bo_2 = 192.00

ho_2 = 492.00

bi2_2 = 557856.00

$psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.25907$

$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.25221$

ps1 (external) = $(A_{sh1} * h1 / s1) / A_{sec} = 0.00261799$

Ash1 = Astir_1 * ns_1 = 157.0796

No stirups, ns_1 = 2.00

h1 = 670.00

ps2 (internal) = $(A_{sh2} * h2 / s2) / A_{sec} = 0.00062519$

Ash2 = Astir_2 * ns_2 = 100.531

No stirups, ns_2 = 2.00

h2 = 500.00

$psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.25907$

ps1 (external) = $(A_{sh1} * h1 / s1) / A_{sec} = 0.00156298$

Ash1 = Astir_1 * ns_1 = 157.0796

No stirups, ns_1 = 2.00

h1 = 400.00

ps2 (internal) = $(A_{sh2} * h2 / s2) / A_{sec} = 0.00025008$

Ash2 = Astir_2 * ns_2 = 100.531

No stirups, ns_2 = 2.00

h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.4444

fywe2 = 694.4444

fce = 33.00

From ((5.A5), TBDY), TBDY: $cc = 0.00232446$

c = confinement factor = 1.03245

y1 = 0.00097781

sh1 = 0.003129

ft1 = 325.9374

fy1 = 271.6145

su1 = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 0.17502824

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 $fs1 = (fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 271.6145$

with $Es1 = (Es_{jacket} * A_{sl,ten,jacket} + Es_{core} * A_{sl,ten,core}) / A_{sl,ten} = 200000.00$

y2 = 0.00097781

sh2 = 0.003129

ft2 = 325.9374

fy2 = 271.6145

su2 = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.17502824

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 = 271.6145

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.00097781

shv = 0.003129

ftv = 325.9374

fyv = 271.6145

suv = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/ld = 0.17502824

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY

For calculation of esuv_nominal and yv, shv,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 = 271.6145

with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.03135046

2 = Asl,com/(b*d)*(fs2/fc) = 0.03135046

v = Asl,mid/(b*d)*(fsv/fc) = 0.01913459

and confined core properties:

b = 610.00

d = 327.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07072

cc (5A.5, TBDY) = 0.00232446

c = confinement factor = 1.03245

1 = Asl,ten/(b*d)*(fs1/fc) = 0.0375932

2 = Asl,com/(b*d)*(fs2/fc) = 0.0375932

v = Asl,mid/(b*d)*(fsv/fc) = 0.02294481

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

v < vs,y2 - LHS eq.(4.5) is satisfied

--->

su (4.9) = 0.20535904

Mu = MRc (4.14) = 9.1356E+007

u = su (4.1) = 1.1029765E-005

Calculation of ratio lb/ld

Lap Length: lb/ld = 0.17502824

lb = 300.00

ld = 1714.009

Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

db = 15.23077

Mean strength value of all re-bars: fy = 694.4444

t = 1.16154

s = 0.80

e = 1.00

cb = 25.00

Ktr = 2.64216

n = 13.00

Calculation of Mu2+

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:

$$\mu = 1.1029765E-005$$

$$Mu = 9.1356E+007$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00028344$$

$$N = 2237.255$$

$$f_c = 33.00$$

$$c_o \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00650344$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.00650344$$

$$w_e \text{ (5.4c)} = 0.00563792$$

$$a_{se} \text{ ((5.4d), TBDY)} = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.25907$$

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.25221$$

$$p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.25907$$

$$p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 694.4444$$

$$f_{ywe2} = 694.4444$$

$$f_{ce} = 33.00$$

$$\text{From ((5.A5), TBDY), TBDY: } c_c = 0.00232446$$

$$c = \text{confinement factor} = 1.03245$$

$$y_1 = 0.00097781$$

$$sh_1 = 0.003129$$

$$ft_1 = 325.9374$$

$$fy_1 = 271.6145$$

$$su_1 = 0.003129$$

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.17502824

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 $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{d})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 271.6145

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.00097781

sh2 = 0.003129

ft2 = 325.9374

fy2 = 271.6145

su2 = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.17502824

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 $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{d})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 271.6145

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.00097781

shv = 0.003129

ftv = 325.9374

fyv = 271.6145

suv = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.17502824

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY

For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{d})^{2/3})$, from 10.3.5, ASCE 41-17.

with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 271.6145

with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.03135046

2 = Asl,com/(b*d)*(fs2/fc) = 0.03135046

v = Asl,mid/(b*d)*(fsv/fc) = 0.01913459

and confined core properties:

b = 610.00

d = 327.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07072

cc (5A.5, TBDY) = 0.00232446

c = confinement factor = 1.03245

1 = Asl,ten/(b*d)*(fs1/fc) = 0.0375932

2 = Asl,com/(b*d)*(fs2/fc) = 0.0375932

v = Asl,mid/(b*d)*(fsv/fc) = 0.02294481

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

v < vs,y2 - LHS eq.(4.5) is satisfied

--->

su (4.9) = 0.20535904

Mu = MRc (4.14) = 9.1356E+007

u = su (4.1) = 1.1029765E-005

Calculation of ratio lb/d

Lap Length: $l_b/l_d = 0.17502824$

$l_b = 300.00$

$l_d = 1714.009$

Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$= 1$

$db = 15.23077$

Mean strength value of all re-bars: $f_y = 694.4444$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

Calculation of μ_2 -

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:

$\mu = 1.1029765E-005$

$\mu = 9.1356E+007$

with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.00028344$

$N = 2237.255$

$f_c = 33.00$

α (5A.5, TBDY) = 0.002

Final value of μ : $\mu^* = \text{shear_factor} * \text{Max}(\mu, \alpha) = 0.00650344$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $\mu = 0.00650344$

w_e (5.4c) = 0.00563792

a_{se} ((5.4d), TBDY) = $(a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$

$a_{se1} = 0.14776895$

$b_{o,1} = 340.00$

$h_{o,1} = 610.00$

$b_{i,1} = 975400.00$

$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$

$b_{o,2} = 192.00$

$h_{o,2} = 492.00$

$b_{i,2} = 557856.00$

$p_{sh,min} * F_{ywe} = \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.25907$

$p_{sh,x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.25221$

ps_1 (external) = $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$

$A_{sh1} = A_{stir,1} * n_{s,1} = 157.0796$

No stirups, $n_{s,1} = 2.00$

$h_1 = 670.00$

ps_2 (internal) = $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$

$A_{sh2} = A_{stir,2} * n_{s,2} = 100.531$

No stirups, $n_{s,2} = 2.00$

$h_2 = 500.00$

$p_{sh,y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.25907$

ps_1 (external) = $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$

$A_{sh1} = A_{stir,1} * n_{s,1} = 157.0796$

No stirups, $n_{s,1} = 2.00$

$h_1 = 400.00$

ps_2 (internal) = $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$

$A_{sh2} = A_{stir,2} * n_{s,2} = 100.531$

No stirups, $n_{s,2} = 2.00$

h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 694.4444

fywe2 = 694.4444

fce = 33.00

From ((5.A.5), TBDY), TBDY: cc = 0.00232446

c = confinement factor = 1.03245

y1 = 0.00097781

sh1 = 0.003129

ft1 = 325.9374

fy1 = 271.6145

su1 = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 0.17502824

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 = 271.6145

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.00097781

sh2 = 0.003129

ft2 = 325.9374

fy2 = 271.6145

su2 = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.17502824

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 = 271.6145

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.00097781

shv = 0.003129

ftv = 325.9374

fyv = 271.6145

suv = 0.003129

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 0.17502824

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,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 = 271.6145

with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.03135046

2 = Asl,com/(b*d)*(fs2/fc) = 0.03135046

v = Asl,mid/(b*d)*(fsv/fc) = 0.01913459

and confined core properties:

b = 610.00

d = 327.00

d' = 13.00

fcc (5A.2, TBDY) = 34.07072

cc (5A.5, TBDY) = 0.00232446
c = confinement factor = 1.03245
1 = $Asl,ten/(b*d)*(fs1/fc) = 0.0375932$
2 = $Asl,com/(b*d)*(fs2/fc) = 0.0375932$
v = $Asl,mid/(b*d)*(fsv/fc) = 0.02294481$

Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)

---->
v < vs,y2 - LHS eq.(4.5) is satisfied

---->
su (4.9) = 0.20535904
Mu = MRc (4.14) = 9.1356E+007
u = su (4.1) = 1.1029765E-005

Calculation of ratio lb/l_d

Lap Length: lb/l_d = 0.17502824

lb = 300.00

l_d = 1714.009

Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

l_{d,min} from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

db = 15.23077

Mean strength value of all re-bars: fy = 694.4444

t = 1.16154

s = 0.80

e = 1.00

cb = 25.00

K_{tr} = 2.64216

n = 13.00

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 383229.931

Calculation of Shear Strength at edge 1, Vr1 = 383229.931

Vr1 = V_n ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) 'V_w' is replaced by 'V_w+ f*V_f'
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: V_c = 197061.477

= 1 (normal-weight concrete)

Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc'^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)

pw = As/(bw*d) = 0.00331157

As (tension reinf.) = 709.9999

bw = 670.00

d = 320.00

Vu*d/Mu < 1 = 0.00

Mu = 2.6257021E-011

Vu = 2.6375953E-014

From (11.5.4.8), ACI 318-14: Vs1 + Vs2 = 186168.454

Vs1 = 186168.454 is calculated for jacket, with:

d = 320.00

Av = 157079.633

fy = 555.5556

s = 150.00

Vs1 has been multiplied by 1 (s < d/2, according to ASCE 41-17,10.3.4)

Vs2 = 0.00 is calculated for jacket, with:

d2 = 160.00

Av = 100530.965

fy = 555.5556

s = 300.00

Vs2 is considered 0 (s > d, according to ASCE 41-17,10.3.4)

Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f \leq 818179.336$

Calculation of Shear Strength at edge 2, $V_{r2} = 383229.931$
 $V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw + f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 197061.477$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c_jacket} * Area_jacket + f'_{c_core} * Area_core) / Area_section = 33.00$, but $f'_c^{0.5} \leq 8.3$
MPa (22.5.3.1, ACI 318-14)

$p_w = A_s / (b_w * d) = 0.00331157$
As (tension reinf.) = 709.9999
bw = 670.00
d = 320.00

$V_u * d / \mu_u < 1 = 0.00$
 $\mu_u = 5.2870952E-011$
 $V_u = 2.6375953E-014$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 186168.454$
 $V_{s1} = 186168.454$ is calculated for jacket, with:

d = 320.00
 $A_v = 157079.633$
fy = 555.5556
s = 150.00

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 0.00$ is calculated for jacket, with:
d = 160.00
 $A_v = 100530.965$
fy = 555.5556
s = 300.00

V_{s2} is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f \leq 818179.336$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rcjars

Constant Properties

Knowledge Factor, = 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, $f_s = f_{sm} = 555.5556$
Concrete Elasticity, $E_c = 26999.444$
Steel Elasticity, $E_s = 200000.00$
Existing Column

New material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 33.00$
New material of Secondary Member: Steel Strength, $f_s = f_{sm} = 555.5556$
Concrete Elasticity, $E_c = 26999.444$
Steel Elasticity, $E_s = 200000.00$
External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00

Cover Thickness, $c = 25.00$
Element Length, $L = 3000.00$
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length $l_b = 300.00$
No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 1.5504614E-010$
Shear Force, $V_2 = -1.2862848E-013$
Shear Force, $V_3 = 20600.458$
Axial Force, $F = -4784.664$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{st} = 709.9999$
-Compression: $A_{sc} = 1668.186$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{s,ten} = 911.0619$
-Compression: $A_{s,com} = 911.0619$
-Middle: $A_{s,mid} = 556.0619$
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{s,ten,jacket} = 603.1858$
-Compression: $A_{s,com,jacket} = 603.1858$
-Middle: $A_{s,mid,jacket} = 402.1239$
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{s,ten,core} = 307.8761$
-Compression: $A_{s,com,core} = 307.8761$
-Middle: $A_{s,mid,core} = 153.938$
Mean Diameter of Tension Reinforcement, $DbL = 15.20$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = 1.0^*$ $u = 0.02156999$
 $u = y + p = 0.02156999$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.00156999$ ((4.29), Biskinis Phd)
 $M_y = 9.0882E+007$
 $L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 1500.00
From table 10.5, ASCE 41_17: $E_{eff} = 0.3 * E_c * I_g = 2.8943E+013$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$
 $y_{ten} = 4.5534001E-006$
with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25 * f_y * (l_b / d)^{2/3}) = 252.1446$
 $d = 357.00$
 $y = 0.22443969$
 $A = 0.010022$
 $B = 0.00564945$
with $pt = 0.00380895$
 $pc = 0.00380895$
 $pv = 0.00232477$
 $N = 4784.664$
 $b = 670.00$
 $" = 0.12044818$

y_comp = 2.7615117E-005
with fc = 33.00
Ec = 26999.444
y = 0.22316008
A = 0.0098972
B = 0.00557012
with Es = 200000.00

Calculation of ratio lb/d

Lap Length: $l_d/l_{d,min} = 0.2187853$

lb = 300.00

ld = 1371.207

Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)

= 1

db = 15.23077

Mean strength value of all re-bars: $f_y = 555.5556$

t = 1.16154

s = 0.80

e = 1.00

cb = 25.00

Ktr = 2.64216

n = 13.00

- Calculation of ρ -

From table 10-7: $\rho = 0.02$

with:

- Condition iv occurred

Beam controlled by inadequate embedment into beam-column joint:

($l_b/l_d < 1$ and With Lapping in the Vicinity of the End Regions

- Condition i occurred

Beam controlled by flexure: $V_p/V_o \leq 1$

shear control ratio $V_p/V_o = 0.15892241$

- Transverse Reinforcement: NC

- Stirrup Spacing $> d/3$

- Low ductility demand, $\lambda / y < 2$ (table 10-6, ASCE 41-17)

= -8.8617823E-022

- Stirrup Spacing $\leq d/2$

d = d_external = 357.00

s = s_external = 150.00

- Strength provided by hoops $V_s < 3/4$ *design Shear

$V_s = 215955.406$, already given in calculation of shear control ratio

design Shear = 1.2862848E-013

- (- ')/ bal = -0.23508642

= $A_{st}/(b_w*d) = 0.00296835$

Tension Reinf Area: $A_{st} = 709.9999$

' = $A_{sc}/(b_w*d) = 0.00697431$

Compression Reinf Area: $A_{sc} = 1668.186$

From (B-1), ACI 318-11: bal = 0.01704038

fc = $(f_{c,jacket}*Area_{jacket} + f_{c,core}*Area_{core})/section_area = 33.00$

$f_y = f_{y,jacket_bars} = 555.5556$

From 10.2.7.3, ACI 318-11: $\lambda = 0.65$

From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000/(87000 + f_y) = c_b/d_t = 0.003/(0.003 + y) = 0.51923077$

y = 0.00277778

- $V/(b_w*d*fc^{0.5}) = 1.1273542E-018$, NOTE: units in lb & in

$b_w = 670.00$

End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (b)

